Board of Scientific Advice for India

ANNUAL REPORT

FOR THE YEAR

1920-21

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Annual Report of the Board of Scientific Advice for India, 1920-21.

SUMMARY OF PROCEEDINGS.

Fortieth meeting held at Delhi on the 28th November 1921.

The programmes of the various departments for 1921-22 and the draft Annual Report of the Board for 1920-21 were considered and accepted.

The Board discussed the Report of the Libraries Sub-committee on the provision of scientific libraries in India and on the perishing of paper in India. It was resolved that the Education Department should be asked to publish the catalogue of scientific periodicals available in India outside Calcutta as soon as possible and that the Libraries Sub-committee should prepare a list of scientific periodicals suitable for libraries in India; that if the catalogue and the list were ready in time the Education Department should be asked to nominate a representative specially to attend the next meeting of the Board to consider the action to be taken. In respect of the perishing of paper the Board referred the question to a Sub-committee to consider what action could be taken on the Report issued by the Indian Institute of Science and to report to the Board before the next meeting.

The proposal made by the Agricultural Adviser to the Government of India to abolish the sections of the Annual Report of the Board for which the Agricultural Department was responsible and a proposal by the Inspector-General of Forests that the Annual Progress Report of Forest Research work in India should be accepted by the Board for inclusion in its Annual Report instead of the special contributions hitherto supplied were discussed. The Board came to the conclusion that the present practice of compiling the Annual Report of the Board should be continued. They regretted they were unable to accept the suggestion of the Inspector-General of Forests, and expressed the opinion that the preparation of a special triennial Report or Review of all scientific work in India for the Board should not be attempted.

The Board then considered the qualifications of a representative of the Education Department to be nominated as a member of the Board. It was resolved that while the Board would prefer the representative of the Education Department to possess scientific qualifications, any nomination that the Education Department desired to make would be welcomed.

A proposal for the establishment of a Marine Biological Station at Port Blair and Andaman Islands was considered. The scheme was referred to a Sub-committee for report before the next meeting of the Board.

APPLIED CHEMISTRY

PART I.—AGRICULTURAL CHEMISTRY

BY

F. J. WARTH, M.Sc.

Officiating Imperial Agricultural Chemist.

SOILS.

Soil Surveys.—In Madras the survey of the Periyar tract has been almost completed.

The traverse survey which is being carried out by Somers Taylor in Behar has been extended to the foot-hills in Santhal Parganas. The deficiency of P_2O_5 already noted was found to be more marked as the hills were approached.

In the Central Provinces, a survey of the lateritic Bhatta soils has been completed by Plymen.

Soil Moisture.—In the Punjab, Wilsdon has continued his work on soil moisture movement. Interesting measurements relating to percolation from flowing water channels have been obtained. It was found that the vertical movement is much greater than the lateral.

Soil Nitrogen.—Somers Taylor has noted marked seasonal variation of Organic Nitrogen in certain Behar soils. The study of this important observation is being continued.

Soil Acidity.—Harler has shown that the acidity and toxicity of Assam tea soils are related to Alumina in solution. The toxicity of the soil may be reduced by treatment with super, potash salts or lime.

Soil gases.—Mukherji has continued his work on formation of CO_2 in grassed and fallow plots at Pusa. It is only during the rainy season that very marked increase in CO_2 on the grassed plots occurs.

Experimental area, Pusa.—Sen has carried out preliminary experiments which show that some marked variations in soil composition occasionally occur. Crop growth can be correlated with these differences.

The crops are however patchy also in places where soil composition is uniform. The factors affecting growth in such areas is under investigation.

MANURES AND MANURING.

The important experiments on availability of ground phosphate when composted with green manure have been continued in Madras.

The relative efficiency of super and ground phosphate in combination with green manure has been tested in Behar. For light phosphate dressings the efficiency of the two manures was practically identical. The ground phosphate however when used in larger amounts causes no further improvement such as is obtained with super.

In the Punjab the value of green manuring on sandy soils as a means of retaining soil moisture has been clearly shown.

Coleman has carried out experiments on the availability of nitrogenous manures on the Red Mysore soil. Am_2SO_4 was generally superior to $NaNO_3$. The latter, it was shown, had a deleterious effect on the soil texture. Green manures were found to be less effective than cakes on this soil.

CROPS.

Sugar cane.—The question of ripening under different soil and climate conditions is under continuous study in Bengal, Behar and Assam.

Sanyal has carried out further experiments on windrowing at Pusa and shown that in certain cases here the condition of windrowed cane is better than corresponding uncut cane.

Oil seeds.—Norris has continued his enquiry on the cocoanut plant and fruit.

Somers Taylor has shown that high or low oil content is generally not an inherited character in castor seed. The oil content was found to depend upon cultivation and upon the degree of maturity of the seed.

Rice.—The rates of assimilation of nutrients and of development of the rice plant are being determined in Bombay.

Charlton in Burma has carried out an investigation on the parboiling of rice. The industry, though important, is a public nuisance owing to the objectionable fermentation which occurs.

Sterilisation by heat and bleaching powder, suppression of anærobic bacteria by blowing air, and frequent changes of water were the methods first tested. They had all to be abandoned for various reasons. Eventually good results were obtained by using acidulated water ($P_h=5$—$P_h=2$) which inhibited bacterial activity.

Opium.—Annett has continued the enquiry on the lines previously described.

In studying the factors influencing the morphine content of the latex he found striking differences in distribution of the alkaloids in the plant.

Codeine was found to be uniformly distributed whilst morphine and with it meconic acid were concentrated in the capsule.

Annett has further improved his process for the determination of morphine for estimating such small quantities as occur in a single capsule. This will greatly facilitate selection work.

Tea.—The officers of the Indian Tea Association have been engaged in studying the tannin content of the leaf and the changes taking place during withering. The tannin content was found to vary considerably not only in plants of different species but also in different plants of the same species.

It was found that the initial moisture content of the leaf was an important factor in controlling the changes taking place during withering. Leaf plucked in the morning in the turgid state developed more tannin during 18 hours of withering than drier leaf plucked later in the day.

Jute.—The composition of the jute plant at different stages of development has been studied by the Fibre Expert in connection with the incidence of fungoid disease.

Beans.—Charlton in Burma has examined a large number of cultures for HCN. content. 5 of these have been chosen for further separation into pure strains.

Cotton.—In Madras it has been found that the staple and colour of lint from a pure variety of cotton was appreciably different when grown on two distinct soil types. The work is being continued.

Indigo.—In Indigo Publication No. 6, by W. A. Davis, a second series of reports of manurial trials carried out by Bihar planters is discussed. On certain areas notably in the Champaran District, Super alone has given very marked increase of crops, both indigo and rabi crops such as oats. The majority of the soils in Bihar however are defective in humus as well as soluble phosphate and in these cases combined treatment with green manures (Sannai) and Super have given big increases of crops. Most of the soils in Bihar have a very high lime content (20 to 40 per cent $CaCO_3$) but a few exceptional soils are deficient in this constituent and need liming to improve texture.

The mode of action of phosphatic fertilisers in Bihar is discussed and emphasis laid in the great increase of root developement and nodule activity due to soluble phosphate.

Indigo Publication No. 8, by W. A. Davis, discusses the conditions affecting the quality of the Java indigo plant, especially indigo content of the leaf. Trials suggest that high quality is associated with a low nitrogen content in the soil, particularly with a low content of nitrate. When indigo is grown with a cover crop, such as wheat or mustard, the indigotin content of the leaf and the possible yield of indigo per acre may be increased 50 per cent or more.

Indigo Publication No. 9, by W. A. Davis, is a note on the possible development of indigo in Assam, where it grows with unusual luxuriance. Details are given of the difficulties encountered at Panchnoi Factory owing to the widely varying character of the water used for steeping from day to day as regards its contents of active indican-splitting bacteria.

Indigo Publication No. 9, by W. A. Davis, deals with the nature of the changes occurring during the extraction of indigo in the ordinary steeping

process. In this publication the very harmful effect of slight oversteeping —one or two hours—on both yield and purity of the indigo is emphasised. Such destructive action occurs when the bacterial fermentation in the vats produces much acidity, due to carbonic acid, the presence of which is very destructive of indoxyl. Different typical fermentations have been studied in detail and the results illustrated by graphs.

Indigo Publication No. 10 is a note by Major W. R. Atkins on the deterioration of indigo seed during storing and on the conditions necessary to avoid this.

APPLIED CHEMISTRY

Part II.—Forest Chemistry

BY

J. L. SIMONSEN,

Forest Chemist, Forest Research Institute, Dehra Dun.

Essential Oils—(1) **Turpentine.**—Experiments on the chemistry of the sesquiterpene longifolene obtained from *Pinus longifolia* have been continued and some light has been thrown on the constitution of this interesting substance. It is hoped that when once the constitution of this substance has been elucidated some technical use may be found for it as at the present time it only finds a limited market as an inferior turpentine substitute. It has been suggested that it might be utilised for mineral flotation and experiments are being made in Burma to determine whether it can be used for this purpose.

(2) **Oil from the leaves of Skimmia laureola.**—The examination of the oil from the leaves of *Skimmia laureola* has been completed and the results have been published (Journal of the Society of the Chemical Industry, 1921, Vol. XI, 126T.).

(3) **Oil from Zanthoxylum seeds.**—The oil from the seeds of one species of Zanthoxylum, which has not been definitely identified botanically, have been examined and shown to contain d-linalol (50 per cent.) phellandrene, dipentene and methyl cinnamate. As this oil would appear to be of some value the oil from other species of *Zanthoxylum* obtainable in India are being examined.

(4) **Camphor.**—The experiments on the yield of camphor and camphor oil from leaves grown in Dehra Dun have been completed and the results published (Journal of the Society of Chemical Industry, 1920, Vol. XXXIX, 296T.). It is hoped to publish shortly a detailed analysis of the acreage yield of camphor with special reference to the question of establishing the camphor industry in India.

(5) **Boswellia serrata.**—Fowler and Malandkar have published details of their method for the separation of the turpentine, rosin and gum from the gum-oleoresin from *Boswellia serrata* (Journal Ind. Inst. Sc., Vol. IV, 27).

Fixed oils.—Preliminary experiments have been made at Dehra Dun on the oils from the seeds of *Garcinia Morella, Garcinia Cambogia, Mimusops Elengi*. The oil from olive seeds grown at Rawalpindi was examined and though the yield of oil was low it was of good quality.

Wood distillation.—Sudborough and Watson with collaborators have published Part III of their researches on wood distillation (Journ. Ind. Inst. Sc., Vol. *III, 281*). This part of the research is concerned mainly with the distillation of certain Mysore and Baroda woods under conditions similar to those used in the previous experiments. The results are given in a number of tables.

Medicinal products.—As the result of a careful analysis of a large number of samples of the leaves and flower buds of *Artemisia maritima* from Kashmir the presence of Santonin has been definitely established. This result has been confirmed in London by Greenish and Pearson (Pharm. Journ., 1921) and the question of the commercial extraction of this valuable drug in Kashmir is under consideration.

Miscellaneous.—Sudborough and Vridhachalam (Journ. Ind. Inst. Sc., Vol. III, 61) have investigated the extraction of tartaric acid from tamarinds. They show that the acid is readily recovered and are of opinion that tamarinds would prove an economic source of tartaric acid. This research confirms an unpublished research made with a similar object by Dr. B. B. Dey at the request of the Indian Munitions Board.

Fowler and Joshi (Journ. Ind. Inst. Sc., Vol. III, 39) have studied the fermentation of cellulose. They consider that it should be possible under certain conditions to generate power gas (methane) by the fermentation of waste cellulose materials which are frequently available in quantity as for example on the West Coast.

A valuable study of the biochemistry of the Mahua flower has been published by Fowler and his collaborators (Journ. Ind. Inst. Sc., Vol. III, 81). For details the original paper should be consulted as the results cannot readily be summarised.

ASTRONOMY

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Solar Physics.—Researches in solar physics are carried on at Kodaikanal under the direction of Mr. J. Evershed. A description of the instruments was given in the report for 1918-19.

Routine Work.—Daily spectroheliographic records are obtained in calcium and in hydrogen light; the routine work also includes visual examination of sunspots and faculæ, sunspot spectra, and bright lines or displaced lines in spots and in prominences. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the observatory are issued. Of the former 66 have appeared and of the latter 2 have been published.

Spectroscopic Research.—The study of the variations in the Sun-arc displacements was continued up to the end of 1920, the spectrograph being adjusted for the spectral region 4300-4500 and remaining unaltered throughout. Local displacements on the Sun's disc were avoided by using general sunlight instead of taking the light from the centre of the disc. A small progressive increase in wave-length is shown in some of the lines, and the mean shifts of these lines for the year 1920 show an increase of about 0·002A as compared with similar values obtained in 1919. The changes of wave-length observed are far in excess of the probable errors of measurement.

A series of spectra of Sun and arc have been obtained and partly measured of the ultra violet region, including the high level calcium lines H and K, two aluminium lines, and numerous iron lines as well as the cyanogen bands. These spectra are taken at the polar and equatorial limbs of the Sun and at the centre of the disc. Other series taken at the same positions on the Sun include the iron lines at the red end of the spectrum and the D lines of sodium. The object in view is to redetermine as accurately as possible the displacements in the Sun of lines representing high levels and low levels, and to find the relation between displacements and wave-length at both limb and centre of disc.

The results of our measures of iron lines in Sun and arc will be used also to determine the absolute wave-lengths of selected lines in the solar spectrum based on the International system of iron arc standards. These will be communicated to the International Committee on Standards of wave-length.

Spectra of Venus have been obtained in December 1920 and in June 1921 with the planet near eastern and near western elongation respectively, and photographs will be continued until the angle Venus-Sun-Earth becomes as

large as possible. The spectra obtained near the elongations yield negative evidence as to the planet's rotation which appears to be much slower than that of the Earth. The shift of the lines in these spectra is practically the same as in the spectrum of direct sunlight, the angle Venus-Sun-Earth being small.

A new auto-collimating prism spectrograph of long focus and high resolving power has been partly constructed in the observatory workshop. It is intended to supplement the grating spectrograph for weak light sources and especially for Venus spectra when the available time of exposure becomes too short for satisfactory grating photographs, owing to the approach of the planet to superior conjunction with the Sun.

Prominence Frequencies.—In the study of the solar prominences a remarkable relation has been found between the eastern excess of prominences in the northern and southern hemispheres considered separately and the heliographic latitude of the Earth. It appears that during the series of years between 1904 and 1917 when there was a constant excess of eastern prominences this excess was always greater in the hemisphere inclined away from Earth than in the hemisphere inclined towards Earth. The mean results indicate that the eastern excess varied in accordance with the sine curve showing the variations in the inclination of the sun's axis to the line of sight.

METEOROLOGY

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Upper Air.—Work with pilot balloons was continued at several stations under the direction of the Agra Upper Air Observatory. The shortage of funds which resulted from a general revision of pay necessitated the closing of the balloon stations at Akyab, Calcutta and Bombay and caused the loss of several trained members of the staff. Nevertheless it was possible to make some headway in the discussion of the upper air data of cloud wind and temperature gathered during the war years.

Normal values of upper winds at nine stations in India were published for the use of aviators, while a discussion of the cloud observations made between 1877 and 1914 was also printed; these two papers form parts IV and V of Vol. XXII of the Memoirs.

Daily and seasonal forecasting.—Shortness of staff prevented any of the gazetted officers from carrying on the preparation of type maps for daily forecasting; but the presence in the Simla office of Mr. J. C. Kamesvara Rao, who was deputed by the Calcutta University to work at meteorology, enabled progress to be made. Mr. Rao has made a careful analysis of all the cold weather storms of the past 20 years.

The methods of forecasting for the cold weather rains as well as for the monsoon have been advanced a stage further. The best result is that for the monsoon rainfall of the Peninsula for which a formula based on 45 years' data of only three factors yields a correlation coefficient of ·73.

Theoretical Meteorology.—An investigation was made into the application of wet bulb temperatures in thermodynamical problems, and some important conclusions about the relationship between adiabatic processes and wet bulb temperatures were arrived at.

A short discussion on dust-raising winds was prepared for publication.

TERRESTRIAL MAGNETISM

BY

GILBERT T. WALKER, C.S.I., M.A., Sc.D., F.R.S.,

Director-General of Observatories.

Magnetic observatories—Bombay (Alibag).—For a description of the instruments and of the routine work reference should be made to the Annual Report of the Director, Mr. T. K. Chinmayanandam.

Magnetic Survey.—No. 18 Party (Magnetic).—The declination, horizontal force and vertical force magnetographs continued in operation throughout the year at the Dehra Dun and Toungoo observatories, and daily absolute magnetic observations were taken regularly by the observers in charge. The observatories were visited during the field season and observations, consisting of declination, horizontal force and dip, were taken for the comparison of instruments.

The Kodaikanal and Alibag Observatories, under the control of the Meteorological Department, were also visited by the officer in charge of the magnetic survey for the same purpose.

Observations at repeat stations.—Six repeat stations at even distances apart, most of them *en route* to the observatories, were selected and observed at this field season. These stations will be visited annually to take magnetic observations with the object of ascertaining in what year, during the interval of the 5-yearly observations at all repeat stations, a turn in the curve of secular change is indicated, so that it may be possible to determine with greater accuracy the rate of annual change which the magnetic elements undergo in different parts of India.

Reduction of observations to epoch.—The reduction of the observations at the field and repeat stations in India, which was last year reported to be under revision, is now well in hand and will be completed about the end of this year.

The magnetic elements at observatories.—The computation and tabulation of the provisional values of dip, declination, horizontal force and vertical force for the three observatories Dehra Dun, Toungoo and Kodaikanal, for the year 1920, have been completed; the mean values of these elements

derived from all days, excluding those of great disturbance, are given in the table below :—

Mean values of the magnetic elements at observatories in *1920.*

Observatory.	Latitude and Longitude.	Dip.	Declination.	H. F.	V. F.
				C. G. S.	C. G. S.
Dehra Dun	30° 19′ 19″ N 78 3 19 E	N. 44° 59 9′	E. 1° 52· 0′	·32951	·32949
Toungoo	18 55 45 N 96 27 3 E	N. 23 7·7	W. 0 23·7	·39114	·16707
Kodaikanal	10 13 50 N 77 27 46 E	N. 4 3·61	W. 1 49·9	·37787	·03042

Great magnetic storm.—A magnetic storm of great intensity, which seriously interrupted the working of the telegraphs in India, was recorded at the observatories from the 13th to the 17th May 1921. The magnitude of the storm was greater and its duration three times longer than the big storms of the 11th and 12th August 1919 and 22nd March 1920. The storm began suddenly and simultaneously in all the magnetic elements at 13h. 8m. G. M. T., on the 13th May; it was practically simultaneous at all the magnetic observatories, to the degree of accuracy with which it is possible to measure time on the magnetograms. There is much similarity in the main features of the disturbance at all the observatories. The horizontal intensity was principally affected, and a prominent feature in this element was the great speed and amplitude of the disturbance between 21h. 20m. and 21h. 41m. G. M. T. Minor rapid fluctuations followed, and the greatest activity in all the magnetic elements began on the 14th at 22h. 15m. G. M. T. ; this lasted for about 10 hours, during which time the movements in the horizontal intensity were so rapid that no record was obtained on the trace in the downward movement, which was the greatest phase of the storm. After this there was a gradual rise in the horizontal intensity up to about 2h. 20m. G. M. T., on the 16th with frequent long and short period oscillations, and between 9h. and 10h., G. M. T., a depression again occurred when the trace once more went beyond the limits of the magnetogram. A gradual rise with minor oscillations then continued up to 7h. 48m. G. M. T., on the 17th when the storm ceased.

It is noteworthy that as usual this storm synchronized with a reported display of Aurorae and with the appearance of large sun-spots.

GEOLOGY

BY

E. H. PASCOE, M.A., D.Sc., F.G.S.,

Director, Geological Survey of India.

Stratigraphy.—The examination of the Tertiary outlier north of Simla was continued. The Shali Limestone was found to be dipping unconformably beneath a bed of white sandstone which has been called the Shali Sandstone and this in its turn was seen to be overlain by the series of slaty shales in which Sir Henry Hayden discovered nummulite bands and which have been called the Madhan Slates. Similar fossils have been found in two other localities in this series. A shelly limestone occurs also in the Madhan Slates, and for some distance forms the boundary between these Slates and a series of older overlying limestones and slates, of which the limestone bears a resemblance to the Krol Limestone. The nummulites in the Madhan Slates, so far as they are determinable, appear to be of Subathu age. The Shali Limestone is therefore either Eocene in age—perhaps the Lower Nummulitic of the Punjab—or Cretaceous. It seems probable that the older limestone and slate overlying the Madhan series has been thrust over the latter, or that an over-fold has inverted the sequence of the beds, the Madhan series having originally been a Tertiary outlier lying upon the older limestone and slate.

During an investigation of the Mandi salt deposits, the presence of bitumen in the associated marls was confirmed. The salt is a stratified deposit, and this recent work tends to confirm the view that it and its associated marls belong to the Subathu stage of the Nummulitic series.

Geological Surveys.—The survey of the ferriferous belt of the Feudatory States of Bihar and Orissa was continued, as was also the general systematic survey of the Central Provinces. Considerable progress was also made with the systematic survey of Mergui. A report on the geology of the Takki Zam valley and the Kaniguram-Makin area in Waziristan will shortly be published. The rocks encountered ranged from a series containing dark blue and black shales and occasional thin black and dark blue limestones, both types being characterised by plant impressions, up to Recent Alluvium. The plant series may prove to be Jurassic. Cretaceous, Nummulitic and Siwalik rocks are all represented, the Murree series not being recognised.

Economic Enquiries.—Investigations were made regarding the following minerals : coal in the Bedadanol coalfield, Godaveri district, Madras ; iron in Keonjhar and Bonai States ; kaolin in the Thaton district of Upper Burma

and also in the Belgaum district of Bombay ; salt at Guma and Drang in the Mandi State, and tin in the Mergui district, Burma.

Several sites for dams were examined and reported on during the year and the question of water-supply was gone into with regard to Matheran near Bombay, Amraoti in Berar, and Taungzin and Kyaukpadaung in the Myingyan district of Upper Burma. The superintendence of the boring for coal below the Deccan Trap at Bhusawal was continued, and a geological reconnaissance of the alignment of the proposed railway up the Ganges valley from Hardwar to Karanpryag was made.

GEODESY

BY

LIEUTENANT-COLONEL H. McC. COWIE, R.E.,
Officiating Superintendent of the Trigonometrical Survey.

The only systematic field work undertaken during the year by the Trigonometrical Survey consisted of Precise Levelling, Magnetic Observations and Tidal Registration. Experiments were made in connection with wireless Longitude determinations and investigations into atmospheric refraction and the adjustment of triangulation nets were continued. No Triangulation was undertaken nor were any Pendulum or Astronomical Observations made.

TIDAL OPERATIONS.

During the past year tidal registration by means of automatic gauges have been carried out at the following ports :—

Aden, Karāchi, Bombay (Appolo Bandar), Bombay (Prince's Dock), Madras, Kidderpore, Rangoon, Moulmein and Port Blair.

All the tide gauges have worked satisfactorily, and there have been no serious breaks in the tidal registration.

All the tidal observatories were inspected during the year and the gauges thoroughly overhauled and put into working order.

In addition to the automatic tidal registration at the nine ports named above, observations of high and low water on tide poles were taken during day light at Bhaunagar, Chittagong and Akyab, with the object of testing the accuracy of predictions which were based on tidal registrations taken many years ago.

The Director, Inland Water Transport, Basrah, has continued to supply to this Department tidal observations taken on a tide pole at Basrah. On the basis of these observations, data for the preparations of tide tables for Basrah for the year 1921 were prepared and supplied to the National Physical Laboratory in England. The predictions were received from the Laboratory in December 1920 and supplied direct to the Director, Inland Water Transport, and Port Officer, Basrah, and the Director of the Royal Indian Marine, Bombay, in December 1920.

Data for the preparation of tide tables for Basrah for 1922 were despatched to the Director, National Physical Laboratory, in January 1921.

Arrangements have been made to transfer the Tide Predicting Machine from the National Physical Laboratory at Teddington to Dehra Dun. This instrument was originally installed in the India Office Stores Department about the year 1879, and subsequently moved to the National Physical Laboratory. It is expected that the machine will be in working order in Dehra Dūn about the end of October 1921, after which date the preparation of Tide Tables will be undertaken in India.

LEVELLING OPERATIONS.

I. *Levelling completed in 1920-21—*

During the season 1920-21, the following lines of precise levels were run :—

A.—*Jacobābād to Hyderābād*, about 350 miles. This line traverses the area commanded by the Sukkur Barrage project and the Manchar Lake Irrigation Scheme, and forms data for irrigation work on the right bank of the Indus. In the course of time many of the old bench-marks had disappeared in this area. The determination of the heights of a considerable number of the Public Works Department bench-marks was completed. The work was of the "high precision" order, executed on the "fore and back" system, and forms one of the lines of the new level net.

B.—*In the United Provinces—*

(*a*) Bareilly to Pīlībhīt (Revision); originally levelled in 1867-68.

(*b*) Pīlībhīt, *viâ* Mailānī, Kherī Lakhīmpur, Sitāpur, Baghauli, Lucknow, Rāe Bārrīely, and Sultānpur to Fyzābād.

(*c*) Mailāni to Shāhjahānpur.

(*d*) Shāhjahānpur to Baghauli.

(*e*) Sultānpur to Allahābād.

This work was undertaken at the request of the Irrigation Department, in connection with the Sarda Canal Project, in order to furnish bench-marks accurately determined and referred to a common origin, which would provide a base to enable the Irrigation Engineers to co-ordinate all their cross-levels throughout the entire lengths of the main canals and their distributaries.

The total distance levelled including branch lines was 596 miles executed on the old system of simultaneous double levelling.

C.—*In Bengal* (including branch lines about 460 miles).

(1) Chākdaha *viâ* Berhampore to Chuādānga, with branch-line from Berhampore to Lālgolā (New).

(2) Poradāha *viâ* Nator, Rājshāhi, Godāgāri and Mālda to Hyatpoor, crossing the Padenā by direct levelling over the Sāra bridge, the observed difference (old-new) of height between the two embedded bench-marks on either bank being 0·112 foot. It was originally crossed by (*a*) Vertical Angles, (*b*) Levelling and (*c*) Tide pole methods.

(3) Jiāganj to Bengal-Bīhar boundary near Farakka police station, 59 miles.

This levelling in Bengal was taken up for the Nadiā Rivers Scheme, and was carried out on the simultaneous double levelling method.

D.—*In Bīhar and Orissa.* (Including branch lines about 230 miles.)

(1) Hyatpoor *viâ* Manihāri to Rautara for the Nadiā Rivers Scheme (New),

(2) Tinpāhār to Bīhar-Bengal boundary near Farakka police station, 26 miles (New, for Nadiā Rivers Scheme).

(3) Darbhangā to Bagahā for the Irrigation Department (New).

The method adopted was simultaneous double levelling.

E.—*Muttra to Māruār Pāli,* in the United Provinces and Rajputana. (Total distance about 360 miles.)

This line was levelled on the " fore and back " system and forms line 107 of the new level net.

F.—*Lahore City Levelling.*

The heights of 259 bench-marks in Lahore were fixed at the request of the Punjab Government in connection with the City Sanitation Scheme. In addition to these, the heights of about 100 traverse stations were fixed in connection with the large scale survey of the city now in progress.

II.—*Levelling for earthquakes.*—

In connection with the results of the levelling in the Srimangal Earthquake area, noted in the last report to the Board of Scientific Advice, it has been decided to send each year a copy of the levelling programme for the ensuing season to the Director of the Geological Survey, and to ask him whether there are any geological faults in the neighbourhood of the lines. Stable check level bench-marks will then be constructed and levelled to during the work, to enable relevelment to be undertaken after any future earthquake in that area.

GEODETIC RESEARCH AT DEHRA DUN

BY

J. DE GRAAFF HUNTER, M.A., SC.D., F.INST.P.

(1) Wireless Longitude Observation.—January—March 1921. A Marconi Multi-valve amplifier and detector, type 55 A, was lent by D. D. A. S.: and Lieutenant C. E. Sketch, 3rd Wireless squadron with 4 B. O. R.'s brought this to Dehra and explained its use. Paris signals were picked up on the third day, and, after that, on most mornings of observations. Nauen (Berlin), Caernarvon and Tokyo were frequently heard. At the outset atmospherics were troublesome. Two aerials were tried, one 72 feet high, in the Survey office compound among trees, and the other 100 feet high on the maidan, in the open. The latter gave somewhat louder signals, but atmospherics were not reduced, as had been hoped. A still greater disturbance was caused by the working of some Central Asian station, on the same wave-length as Paris. Quetta interfered several times, until the Director of Wireless issued orders that there should be no signalling of messages at the time of the time signals.

The Paris signals are of two kinds (1) ordinary, in which the precise times 11-45, 11-47, 11-49 (night) are indicated by the beginning of a bar, after suitable warning signals, and (2) scientific, in which 300 dots equally spaced are sent out in about 293 seconds, beginning shortly after 11-00 (night, Greenwich time). The precise times, to 0·01 second, of first and last dots, are signalled after the ordinary time signals are finished. These dots are heard in a double telephone receiver, in which the clock beats are also made audible. The dots gradually overtake the clock beats, and it is only necessary to note the moment at which the two coincide, as they do 5 times in a set.

Coincidences were successfully noted on 5 mornings by Dr. Hunter, and on two mornings by Major Mason. Time stars were taken before and after the wireless signals. The results obtained cannot at present be cleared of personal equation in time determination, as the Dehra transit is not fitted with an "impersonal micrometer."

The following are the values of the difference of Longitude from Greenwich that have been determined :—

5 hours 12 minutes 11·220 seconds, by Dr. Hunter } by wireless 1921,
5 „ 12 „ 11·383 „ , by Major Mason. } by wireless 1921,
5 „ 12 „ 11·267 „ , by Sir Sidney Burrard, and Sir Gerald Lenox-Conyngham in 1894-96 by ordinary telegraph by land and sea.

The experiments have shown the feasibility of the method for determining the longitude of any Indian station, by direct reference to the Greenwich meridian. It is also clear that it is necessary to fit an "impersonal micrometer" to transit instruments used for this work.

(2) Investigation of atmospheric refraction.—It was noticed in 1913 (*vide* Professional Paper 14 Survey of India, chapter iv) that the diurnal change in refraction was in some cases very closely a linear function of the temperature. In two cases examined the greater diurnal change occurred on the shorter ray. This was considered surprising and no explanation was forthcoming. In relation with this question simultaneous observations of barometers at Mussoorie and Dehra were made at several hours of the day for 23 days. The difference of height of the two barometers was deduced by formula from these readings and was found to differ from the spirit levelled difference of height by amounts which varied at the different hours as follows :—

Hour.	8	10	12	14	16
Barometric height *minus* Spirit Level height in feet.	—65	—19	+7	—4	—17

In endeavouring (1921) to explain the diurnal change in refraction, an attempt was made to work out the relation between temperature variation of the air at various heights with that at ground level. It appears that the variation may be split up into two parts (1) conduction effect, (2) radiation effect. The first effect diminishes rapidly with height, and at 100 metres will not exceed 1 per cent, of its value near the ground. The second effect, probably depending a good deal on the state of humidity, should be much the same at all heights dealt with.

As regards the refraction, the second effect has but little influence ; for the main determining factor is the gradient of temperature with height. The conduction effect is very much greater. Its effect is easily computed for a ray of light which soon passes out of the conduction region. If α is the angle of elevation of the ray and $\delta\tau_c$ is the portion of the variation of temperature from its maximum value, which is due to conduction, the change in refraction resulting is given by applying $\mu \sin \phi = \mu' \sin \phi'$ at the ground level and at a height of (say) 100 metres. Then $\delta\mu \propto \delta\rho \propto \delta\tau$ and the refraction $= A\delta\tau_c \cot \alpha$ where A is a physical constant. It is found in cases dealt with that if $\delta\tau_c$ is taken equal to $\frac{5}{6}\,\delta\tau$, where $\delta\tau$ is the defect of temperature near surface from maximum, that the observed changes in refraction are closely explained.

It appears that the radiation portion $\delta\tau_r$ of the temperature variation is of the form $a\,\delta\tau + b\,\frac{d\tau}{dt}$, t being the time. In the barometric formulæ it is necessary to get the mean value of $\frac{1}{\tau} = \left(\frac{1}{\tau}\right)_m$: usual formulæ have put this

equal to $\frac{2}{\tau_1 + \tau_2}$ where τ_1, τ_2 are the temperatures observed at both ends. This value of $\left(\frac{1}{\tau}\right)_m$ is not likely to be correct when there is a much larger variation of temperature near the surface than in the higher layers of air. In fact it is clear that much better results will be obtained if $\delta\tau_c$ is applied to the observed temperatures. The barometer results uphold this view and the observations at 8, 10, 12 hours fall nearly on a straight line when plotted against temperature observed near the ground. Observations at 14 and 16 hours fall distinctly to one side of this line. The explanation seems to be in the term $\frac{d\tau}{dt}$; in fact an empirical expression $a'\,\delta\tau + b'\,\frac{d\tau}{dt}$ can be found which closely represents the tabular quantities given above. This also leads to the partition of temperature variation into two parts about in proportion of 5 : 1 due to conduction and radiation respectively. What has been said about conduction effect is primarily applicable to a station in a plain. At a hill top convection will cause a readjustment. On this account the diurnal variation in refraction from a hill station is less than it would be at a plateau station. Observation has shown this to be the case.

According to this reasoning the following seems to be probable—

(1) The line representing temperature of air plotted against height is practically straight at about 14 hours, right to within a few feet from ground.

(2) At earlier hours in the day the general slope of this line is not much changed ; but it is displaced as a whole to a smaller temperature and its termination near (say within 100 metres of) the ground is now curved towards the direction of lower temperature, the curvature increasing as the earth is approached.

It now appears possible to represent the refraction on a ray which does not lie close to the ground, at any time in the form, $kc + f\,A\,(\tau_m - \tau)\cot\alpha$ in which c is the length of the ray in seconds of arc, k is a factor depending on temperature and pressure of the air at the observing station, α is the angle of elevation of the ray, τ is the temperature and τ_m its maximum value, A is a constant and f is a factor so far found to be about $\frac{5}{6}$.

The observations to determine the height of Mount Everest have been partially dealt with, using this formula and this has resulted in improved accordance in the height obtained by each observation.

(3) **Adjustment of triangulation networks.**—The simultaneous adjustment of a network of triangulation to surrounding triangulation according to the general method of least squares involves the solution of such a great number of simultaneous linear equations as to be quite impracticable. To solve say 20 simultaneous equations is a work which will occupy a computer the best part of a week ; and when it is remembered that the labour increases

as the cube of the number of equations it will be seen that to solve say 100 simultaneous equations will occupy some two years making no allowance for mistakes. Now in a network the errors to all the angles enter the equations simultaneously, so that quite a small network would give rise to an enormous amount of labour. By a little generalisation the problem may be solved in a way which leads to results wholly consistent *inter se* and departs but little from the adjustment which is most probable.

First consider the case of a network of equilateral triangles all of the same size, with angles all equally carefully measured and so all having the same probable error. Consider next that the size of these triangles is small compared with the area dealt with. Both of these modifications lead to a case not seriously different from the actual case — for it is always the object of the triangulator to select triangles nearly equilateral. We are led then to the case of a uniform plate which has to be strained to fulfil certain given conditions of closure.

If we take ξ and η to be the movement of any point parallel to axes Ox, Oy and introduce the condition that at any point the scale value and azimuth is changed by the same amount for all azimuths, the following equation must hold $\frac{\delta^2 V}{\delta x^2}+\frac{\delta^2 V}{\delta y^2}=0$ ...... (1) where V is put equal to ξ or η.

Also $\frac{\delta\xi}{\delta x}=\frac{\delta\eta}{\delta y}$ and $\frac{\delta\xi}{\delta y}=-\frac{\delta\eta}{\delta x}$ (2) It also follows that the change is in azimuth δA and in scale value ϵ (*i.e.*, new scale : old scale : $1+\epsilon : 1$) that δA and ϵ are of form $\frac{\delta\xi}{\delta x}$ and $\frac{\delta\eta}{\delta y}$. These values are applicable to a point. To find the effect on a line they have to be integrated along that line, which is easily done. The problem is accordingly reduced to the solution of (1) subject to the given closing conditions.

The solution of (1) is of form $\Sigma A_n r^n \cos(n\theta+\delta_n)$. By taking enough terms it is possible to satisfy any number of conditions : whereby suitable values of A_n and δ_n are obtained. It is to be noted here that the number of simultaneous linear equations for solution is equal to the number of conditions to be satisfied.

A variety of solutions can be found : but it is clear that the most probable one is that which involves the smallest values of n and this solution is the actual most probable solution of the hypothetical case.

The solution is simple when there are only a few conditions to be satisfied—say the closure on a single side, which involves the solution of only four simultaneous equations.

After the equations have been solved it is necessary to compute values of ξ, η, at sufficient numbers of points to draw contours of equal value ; and this is the heaviest part of the work if large values of n occur. If this is done on tracing cloth, it can be superposed on the chart of triangulation and the correction at any point may be immediately read off.

To visualise the process we introduce the idea of change of azimuth and scale *at a point*, and so imagine in actual triangulation that the rays joining the points become slightly curved. If we imagine a plate of uniform strength with the triangulation marked out on it, then by straining the plate (within its elastic limits, and without buckling it) to fit the closures, all the triangulation on it would be deformed in the way described. It is clear from this that the actual case would be represented by the distortion of the plate of strength varying from point to point which enables us to estimate how far the solution departs from that actually most probable. The method has been devised primarily to deal with adjustment of minor triangulation.

BOTANY

I.—BOTANICAL SURVEY

BY

A. T. GAGE, LIEUT.-COL., I.M.S.

Director, Botanical Survey of India.

Systematic.—Eastern India and Burma.—In the forests of the northern third of Tavoy District in Southern Burma, Mr. P. T. Russell, Superintendent of Cinchona Cultivation there, has made excellent collections. The Director visited the same area early in 1921 and also brought back a collection. The district is botanically rich and these preliminary collections have already yielded rare and interesting species. The distribution of Floras in S. E. Asia as affected by the Burma-Yunnan range of mountains, has been studied by Captain Kingdon Ward. In the Kew Bulletin has been published a paper by the late Major S. M. Toppin, M.C., on the Balsams of the Kachin Hills. In the same journal descriptions of the new species in the collections made by Mr. I. H. Burkill some years ago in the Abor Hills continue to appear. In Notes from the Royal Botanic Garden, Edinburgh, Sir Isaac Balfour and W. W. Smith have published new species of *Primula*, *Omphalogramme*, *Rhododendron* and other genera from the Eastern Himalaya and Upper Burma.

Northern India.—Part II of Vol. III of the Flora of The Upper Gangetic Plain, by J. F. Duthie appeared in 1920. It contains the families from *Coniferae* to *Juncaceae*. This work is now nearly finished, and it is hoped that by another year publication will be completed. Mr. R. N. Parker of the Imperial Forest Service has discovered several hitherto-undescribed species in the North Western Himalaya. Professor S. R. Kashyap has published an interesting note on the vegetation forming the floating islands of Riwalsan, a lake in Mandi State. The Balsams of Chitral are referred to in Major Toppin's paper mentioned above.

Western India.—The Rev. Father Blatter and Professor Hallberg continue to show great activity on this side of India, their contributions to botanical literature during the year including a paper on new species of various genera found in the Bombay Presidency, studies of the Flora of Jodhpur and Jaisalmer, and of the Flora of Baluchistan. The drought resisting plants of the Deccan form the subject of a paper by Mr. R. K. Bhide.

Southern India.—During September and October Mr. V. Narayanswami of the Botanical Survey explored the Rampa country of the Godavari District. His collections, ranging from 500 to 4,500 feet of altitude are being worked out as opportunity allows, and promise interesting results. Collections were also made in Alamanda, Polakol, the Pulney and Nilgiri hills and in Kasargode and Tinnevelly by Mr. K. Rangachariar Avergal, the Madras Government Systematic Botanist and his assistants. The same botanist has under preparation separate lists of plants for the various districts of the Madras Presidency to facilitate compilation of district Floras hereafter. Mr. J. S. Gamble, C.I.E., has published in connection with the preparation of his Flora of Madras a fresh lot of new species from Southern India. The *Volvocaceæ* of Madras form the subject of a paper by Mr. Ayyangar.

General.—A large number of papers not concerned with purely regional botany have appeared during the year, of which only a selection can be mentioned here. Mr. H. H. Haines, C.I.E., has cleared up a nomenclatural confusion hitherto obscuring the use of the names *Amoora spectabilis* and *A. Wallichii* and *Sapindus trifoliata* and *S. laurifolia*. Dr. H. H. Mann has published an account of variation in the flowers of *Jasminum malabaricum*, and Mr. S. H. Prayag observations on the inflorescence and flowers of the grape. The physiological anatomy of the plants of the Indian desert has been studied by Mr. T. S. Sabnis and the structure of some Cucurbitaceous tendrils by Mr. K. D. Sawhney. The œcological aspects of the vegetation of the Upper Gangetic Plain have been investigated by Dr. W. Dudgeon. A case of atrophic abortion of the inflorescence of the Onion has been recorded by Mr. P. M. Debbarman.

II. Economic.—During the year Cinchona work in Tavoy has been continued under the difficult circumstances inseparable from all pioneer work in trackless tropical forests. So far as nursery work is concerned the results have been excellent, seedlings germinating and growing very well. The real test, however, as to how the young plants when planted out in the open, will stand the heavy monsoon precipitation that occurs in the south-western corner of the reserved area, where operations have been started, has yet to be passed. If the young plants planted in the open at the beginning of the monsoon do not come through it satisfactorily, it does not necessarily follow that the whole reserved area is to be incontinently condemned as unsuitable. It may be found that altering the period of planting out from the beginning of the monsoon to near its end will enable the young plants to be sufficiently established to withstand the full fury of the following monsoon. On the other hand it may be found necessary to move further inland, or to the southern third of Tavoy District or the northern third of Mergui District, where the rainfall is considerably less than in North Tavoy. Another year's experience will be necessary, before sufficient data can be gathered on which to base a definite opinion as to the future action to be taken.

BOTANY

II.—ECONOMIC BOTANY

Part I.—Agricultural Botany

BY

ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S.,

Imperial Economic Botanist.

The present report, which is limited to four pages of print, deals with the progress of Agricultural Botany in India during the year ending June 30th, 1921. Under these conditions, the best course would appear to be to limit this paper to an account of the more important results published during the year and to refer the student of Indian agriculture for further details to the various other annual reports and periodicals issued by Government which deal with the same subject but in greater detail.

The following publications contain a considerable amount of information on the improvement of crops :—

(*a*) *Review of Agricultural Operations in India.*—This is an annual report, prepared by the Agricultural Adviser to the Government of India, Pusa, Bihar, and deals, among other matters, with the distribution of improved seed in various parts of India. It also contains a classified list of papers on Indian agriculture published during the year.

(*b*) *Scientific Reports of the Agricultural Research Institute*, Pusa (including the Reports of the Imperial Cotton Specialist and of the Sugar Bureau). Copies can be obtained from the Director, Agricultural Research Institute, Pusa, Bihar.

(*c*) *Administration Reports of the Provincial Departments of Agriculture.*—Bombay, Bengal, Madras, Central Provinces, United Provinces, Punjab, Bihar and Orissa, Assam and Burma. These are issued by the Government presses in these Provinces towards the end of each year and contain a general summary of the work of the Agricultural Department (including the farm reports) and also the annual reports of the Economic Botanists. These administration reports largely form the basis of the annual *Review of Agricultural Operations in India.*

(*d*) *Proceedings of the Board of Agriculture in India.*—This contains the programmes of work in progress in Economic Botany as well as discussions on matters relating to the Agricultural Department as a whole. Copies can be obtained from the Agricultural Adviser to the Government of India, Pusa, Bihar.

(*e*) Many of the original papers on Agricultural Botany in India are published in the following periodicals :—(1) *Memoirs of the Department of Agriculture in India* (*Botanical Series*), (2) *Bulletins of the Agricultural Research Institute, Pusa* and (3) The *Agricultural Journal of India.* This latter contains classified lists of all papers published on Indian agriculture. Copies of these publications can be obtained from the Director, Agricultural Research Institute, Pusa.

The number of original papers which appeared during the year under review is smaller than usual due to the absence on leave of several of the investigators, to the promotion of others and to vacancies among the superior staff. A number of important papers, however, have recently been submitted for publication and are now in the press. These will be dealt with in the next report.

Cotton. An account of Kumpta cotton (*G. herbaceum* L.) has been published by G. L. Kottur (*Mem. of the Dept. of Agr. in India, Botanical Series*, X, 221). The paper contains full details of the distribution of this cotton in the Dharwar tract and of a number of promising selections which have been isolated. Further work on the improvement of these types by hybridization is in progress. Several papers dealing with the cotton flower have recently appeared. G. L. Kottur (*Agr. Jour. of India*, XVI, 52 and 406) working in the Southern Division of the Bombay Presidency with types of *G. herbaceum*, *G. neglectum* and Dharwar American cotton considers that continuous self-fertilization for a number of years does not encourage self-sterility. Further work on this question is desirable as other workers state that continuous selfing may be injurious. The matter can only be cleared up by critical work extending over a number of years on unit species of a number of the different varieties. K. I. Thadani in Sind (*Agr. Jour. of India*, XV, 393) finds from a study of single plant cultures that from 5 to 8 per cent. of natural crossing takes place. In several cases, cleistogamic flowers were noticed on plants going off their bloom. G. R. Hilson (*Agr. Jour. of India*, XVI, 235) gives an account of the deterioration of Cambodia cotton in Madras and the methods of improvement in progress.

Rice.—G. N. Rangaswami (*Agr. Jour. of India*, XVI, 156) has published an interesting account of the methods in use at Coimbatore in the breeding of swamp rice. K. V. Joshi (*Poona Agr. College Mag.*, XII, 4 and 106) has commenced a series of papers on this crop. In transplanting, the old roots die, new ones being produced from 24 to 48 hours afterwards. In a week, the plants begin to recover from the process and with the rapid formation of the

secondary root system the crop loses its faded yellow colour and turns green. S. C. Roy (*Agr. Jour. of India*, XVI, 365) has published a preliminary classification of the wild rices of the Central Provinces which are important weeds in the rice areas of this tract mixing readily with the cultivated forms on account of the premature falling of the grain.

Sugarcane.—C. A. Barber, in the issue of the *International Sugar Journal* for October 1920, concluded a series of ten papers on the growth of the sugarcane. T. S. Venkatraman and R. Thomas (*Agr. Jour. of India*, XVI, 24) gives their experience of the methods tried at Coimbatore in dealing with imported sugarcane varieties during the first years of their trial under new conditions. N. V. Rao (*Agr. Jour. of India*, XV, 418) deals with the importance of habit in sugarcane varieties.

Indigo.—W. R. G. Atkins (*Pusa Indigo Publications*, 10) has investigated the deterioration of indigo seed during storage. The results indicate the importance of the seed being well matured before gathering. Those seeds with specially resistant cuticle retain their germinative vigour to the greatest extent.

Opium.—H. E. Annett and his assistants (*Bull. 116, Agr. Research Inst., Pusa*) find that the type of improved opium poppy recently isolated at Cawnpore does not produce opium of the same morphine content in every district. There appears to be some local factor still to be investigated which influences the power of the plant to form morphine. Certain Districts, such as Etawah, Cawnpore, Budaun and Bareilly, produce opium of high morphine content while others such as Fyzabad, Gorakhpur and Rai Bareli yield a drug much lower in morphine.

Fibres.—Two papers on fibres have appeared during the year. B. C. Burt (*Agr. Jour. of India*, XV, 616) gives the results of preliminary experiments with flax at Cawnpore and discusses the possibilities of establishing a flax industry under canal irrigation on the alluvium. R. S. Finlow (*Agr. Jour. of India*, XVI, 265) has published an historical account of his experiments on jute in Bengal including the problem of the seed supply of improved types to the cultivators.

Fruit.—W. Burns and S. H. Pryag have published a detailed account of the mango in Bombay in Bulletin 103 of the Bombay Department of Agriculture. Although the paper is intended for growers, there is a useful chapter on the flowering and pollination of this tree and a classification of mango varieties. Several other papers on fruit have appeared in the *Agricultural Journal of India*. W. Burns and P. G. Joshi deal with the "top-working" of the mango. S. H. Pryag has written a general paper on the influence of the stock on the scion and has made some observations on the inflorescence and the flowers of the grape. The root systems of the guava and of the orange have been studied by Burns and Kulkarni under the soil conditions obtaining in the Deccan.

Millets.—L. C. Coleman and his staff have published an exhaustive account of the cultivation of *ragi* (*Eleusine coracana*) in Mysore and of the results obtained on this crop at Bangalore. Cross-fertilization is stated to be practically impossible under Mysore conditions, a fact which has greatly simplified the testing of varieties and the distribution of seed.

Forage plants.—The important question of the improvement of the poor grazing areas of the Deccan has been taken up by W. Burns and G. M. Chakradev (*Jour. of Indian Botany*, II, 84). An area of denuded grazing land has been leased for five years near Poona. This has been fenced and careful observations on the changes in the flora are being made. The results so far obtained are of considerable interest. Even in the higher and rocky parts of the area, the good perennial fodder grasses *Iseilema laxum* and *Andropogon monticola* have firmly established themselves. It is considered probable that the climax will be an *Acacia arabica* forest and that the ideal condition would be grass land containing the better fodder grasses with a scattered growth of this tree sufficient to shade not more than a tenth of the land. L. B. Kulkarni (*Agr. Jour. of India*, XVI, 388) gives an account of the importance of the grass *Andropogon purpureo-sericeus* in the Bombay Deccan. D. Clouston and F. J. Plymen (*Agr. Jour. of India*, XV, 380) have published an interesting paper on the principal fodders of the Central Provinces including the small bamboo (*Dendrocalamus strictus*). This plant promises to be a most useful fodder on poor light soils which cannot be irrigated. From the outturns already obtained, there is reason to believe that yields of from 40 to 60 tons of leaf per acre can be obtained from this variety of bamboo three years after planting. The authors state that "it should be possible in parts of India where tracts of poor land are available and where the rainfall is suitable, to establish bamboo fodder reserves from which useful supplies of green fodder could be obtained for seven or eight months of the year and from which bamboo hay could be made for utilization in years of fodder famine."

BOTANY

II.—Economic Botany

Part II.—Forest Botany

BY

R. S. HOLE, C.I.E., F.C.H.,
Forest Botanist.

Oecology of Sal.—The result of the sowings made in June 1920, in the local Dehra Dun forests, has supported the results obtained in previous years, *viz.*, that sowings in small clearings are more successful than sowings under partial or complete overhead cover. The development of the older seedlings, also, has now clearly demonstrated the fact that, by artificial sowings in these clearings, seedlings can be raised in the local forests with little or no dying back and which attain a height of 6 feet in 6-7 years. A factor which has assumed some importance during the year with reference to the development of these older seedlings is the damage done by rats and porcupines which destroy a number of vigorous young seedlings by eating through the sappy taproots. It is believed that this kind of damage will be relatively unimportant when work is carried out on a larger scale and the supply of vigorous young seedlings is greatly increased. A very similar state of things has been noticed in the case of damage to the seed. In bad seed years when very little seed is available in the local forests, porcupines and other animals destroy a large proportion of the seed in the artificially sown areas, whereas in good seed years practically no damage is done. The main principle which has emerged from the work done up to date on this subject is that, in order to accelerate the growth and establishment of sal seedlings, it is necessary to secure, as far as possible, favourable conditions of soil-moisture and soil-aeration throughout the year, that these conditions can often be greatly improved by making small clearings, with a suitable arrangement and degree of side-shade, and by raising the seedlings in these open areas instead of under the shade of the forest.

In this way, favourable conditions of moisture and soil-aeration can be secured, dense and vigorous weed growth is not produced, frost damage is avoided and the soil surface does not become injuriously hardened or compacted. Whatever the precise systems of management may be which are ultimately adopted to suit the local conditions prevailing in the various types of sal forest, it is probable that increasing attention will be paid to the importance of this principle in the Indian Working Plans of the future.

It is satisfactory to note that the Conservator of Working Plans in the United Provinces has now agreed to test the suggested group-*cum*-strip system of regeneration, experimentally, on a larger scale than has been possible up to date.

Local officers in the United Provinces have also initiated large scale experiments with the object of determining the best way of applying the principle in question to sal forests which are managed under the uniform method of treatment.

Oecology of Teak.—In 1916 the Forest Botanist published the results of experiments which showed that clear felling had a decidedly favourable effect on the germination of the seed and on the development of the seedlings of teak (*Indian Forester*, XLII, pp. 51-57). During the year this matter has again received attention in an interesting article by the Hon'ble Mr. J. W. Best in the *Indian Forester*, XLVI, pp. 411-415, where the opinion is expressed with reference to teak plantations in Berar that " clear felling in strips is likely to lead to the best results." There is little doubt that the principles which have been found to apply to sal will also be found to apply to a considerable extent to teak, also, and it is believed that there is considerable scope now in *India* for oecologists working in co-operation with forest officers, in devising improved methods of treatment for many of our important species, the seedling growth of which is, at present, often unsatisfactory and very slow.

Root Disease of Sal.—Caused by *Polyporus Shoreæ*. In co-operation with Dr. Shaw of Pusa a number of healthy sal saplings at Dehra Dun were inoculated with *Polyporus Shoreæ* in 1916 by the Assistant Forest Botanist, Mr. Abdul Hafiz Khan. During the year under report, several of these saplings were dug up and examined. The results so far obtained indicate that, while the fungus is unable to attack a healthy unwounded root, successful inoculations were invariably obtained when the mycelium was placed in contact with the wood in the interior of the root by means of a wound. It is interesting to note that Mr. W. E. Hiley, in his recent work on the larch in the United Kingdom, has come to the conclusion that good soil-aeration is of great importance for that species and that the fungus *Fomes annosus* gains an entrance into this tree through roots which have been killed by bad soil-aeration (*Fungal Diseases of the common Larch*. Oxford, 1919, p. 184). It is probable that the most effective means of controlling troublesome root diseases such as that of the sal mentioned above and that of *Dalbergia Sissoo* caused by *Fomes lucidus* will consist in improved methods of treatment which will ensure a better water-supply and condition of soil-aeration.

The Forest Botanist attended the conference of mycologists at Pusa in February and read a paper on the physiology of disease.

Systematic.—The Forest Botanist, while on leave, studied the material in the Kew herbarium of the genus *Tamarix*. Mr. H. H. Haines continued work on the Forest Flora of Bihar and Orissa and the following publications are under preparation :—

A revised edition of the *Forest Flora of the Punjab* by Mr. R. N. Parker, a *Forest Flora and Descriptive Lists for Assam* by Rai Bahadur Upendranath Kanjilal and *Descriptive Lists* for the United Provinces by Messrs. A. E. Osmaston and P. C. Kanjilal. Mr. C. E. Parkinson has completed his draft of the *Forest Flora of the Andamans.* A new species belonging to a new genus *Dioticarpus Barryi* Dunn was discovered by Mr. D. T. Barry in Tinnevelly.

BOTANY

II.—ECONOMIC BOTANY

Part III.—Mycology

BY

F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S.,

Officiating Imperial Mycologist.

Agricultural Research Institute, Pusa.—The following is an account of the chief investigations carried out at Pusa during the year :—

Cereal diseases.—The study of the genus *Helminthosporium* on cereals and sugarcane was continued by Mr. M. Mitra. The cultural study of the species found on maize, jowar, sugarcane, rice, wheat, and barley was completed. All these, together with the four strains on wheat, were cultivated on a large number of media of different chemical constituents, and also on sterilised straw of paddy and wheat. They were also kept at different temperatures. No perfect stage of any of them was discovered. Some of the species kept constant characters in a particular media, even when grown on it repeatedly, but others such as *H. teres* Sacc. on barley, *Helminthosporium* on wheat from Pusa and Burma, and *Helminthosporium* on sugarcane showed occasional changes in the character of growth and also in the size of spores formed. Thus *H. teres* Sacc. of barley has sometimes a dark growth, sometimes a snowy white and wooly growth and occasionally a pinkish white growth. Similarly *H. Sacchari* Butl. generally produces a good aerial growth but sometimes a subculture gives a creeping dark mycelium full of spores and with very little aerial growth. Again a subculture from this may give rise to an aerial growth, or may keep the character of the parent culture for some time and then again revert to its old habit. Spores are also variable in size. *H. teres* Sacc. on barley produces pycnidia and chlamydospores on sterilised wheat straw. The latter have not been described before.

The study of *Helminthosporium* on maize and jowar was concluded. The species on maize and jowar appears to be two different strains of *H. turcicum* Pass. It is interesting to note that *Helminthosporium* is found on maize only, and not on jowar, in Bihar, and *vice versa* in the Punjab. From the results of cross-inoculations it is concluded that there is no specialisation of parasitism and that the fungus from one host can infect others. Thus cross-inoculations

with *Helminthosporium* on maize and jowar give reciprocal results and infections are also successful on sugarcane, wheat, barley, oat and to some extent on rice, but not on bajra. Rice and sugarcane *Helminthosporium* give positive results when cross-inoculated on maize, jowar, wheat, oat, barley, rice and sugarcane. All the four strains on wheat give positive results on rice, maize, jowar, oat and barley and some also on sugarcane. *H. teres* Sacc. which does a good deal of damage to barley in Pusa was inoculated with success on wheat, maize, rice, jowar and oat.

Helminthosporium on wheat, one of the causes of "Foot rot," was obtained from America and is being compared in culture with the forms on wheat and barley occurring in Pusa. On sterilised wheat straw, it agrees very much with *H. teres* Sacc. on barley and on wheat in Pusa. *Helminthosporium* on barley and oat does good deal of damage to seedlings and young plants. Last year it was present to a large extent on oats. It is intended to try control measures by treating the seeds before sowing.

Acrothecium lunatum Wakker has been found on *Setaria italica* Beauv., Sawan (*Panicum frumentaceum* Roxb.) and *Eleusine coracana* Gaertn. It forms small elliptical or elongated brownish or straw colour spots but it is not very common. It occurs on many other plants also and appears to be a weak parasite. A memoir was published on *Acrothecium Penniseti* n. sp. on bajra.

Miscellaneous.—The research work on diseases of paddy caused by *Piricularia* was continued by Mr. McRae. The results of Mr. Dastur's work on *Choanephora* and Anthracnose of chilli were published during the year under review and a paper dealing with "die back" of chillies (*Capsicum* spp.) in Bihar is in the press. A paper on the mode of infection of sugarcane with smut was published and the causes of the immunity of thick canes to this disease are being studied in the light of this new information.

The bud rot disease of palmyra palms, which has long been one of the major fungal diseases of Madras, appeared in the Burdwan district of Bengal. This new outbreak and a disease of areca palms in Assam, is being investigated. *Urocystis coralloides* Rostrup a rare smut on mustard was discovered for the first time in India in the vicinity of Pusa and was identified at the recently created Imperial Bureau of Mycology.

Other Scientific Departments.

Madras.—The operations against the bud rot of palmyra palms were continued under the new Pest Act by which owners are compelled to cut down dead trees. The results obtained during the past year showed an improvement on preceding years—the number of dead and outwardly infected trees being reduced. The appearance of this disease in Bengal, and the question whether infection reached Bengal from the Godavari, has to be investigated. Spraying of grape vines against mildew was extended during the past year with most beneficial results, the yield from 239 vines

rising from Rs. 710 to Rs. 3,950. Spraying was also carried out against the mahali disease of areca-nuts. The intensity of this disease appears to be waning.

Seed treatment against the smut diseases of cholam (*Sorghum vulgare*) and tenai (*Setaria italica*) was carried out in Bellary, Kurnool and Anantapur. Approximately 32,000 acres were sown with treated seed and the decreased incidence of disease may be estimated to have resulted in a gain of about Rs. 100,000 to the cultivator.

The treatment of "bleeding disease" of coconuts, by surgical excision of the diseased tissue and flaming and tarring the exposed surface, proved successful and was introduced among garden owners in the coconut growing areas.

Other diseases under investigation are a disease of ginger caused by *Vermicularia*, the long smut (*Tolyposporium filiferum*) of cholam and the green ear disease of cumbu (*Pennisetum typhoideum*). A paper on the *Helminthosporium* disease of paddy is in the press. This disease appears to be of minor importance and only causes serious damage under conditions which are favourable to the development of the fungus.

Bombay.—Various smut diseases were investigated. Experiments with smut on *Eleusine coracana* failed to afford proof that the disease was carried on the seed. Smut on *Panicum frumentaceum*, however, proved to be seed borne and will probably yield to the usual seed steeping in copper sulphate. A variety of *Sorghum*, known as "milo," which is reported to be resistant to smut in America, proved to be very susceptible to Loose Smut (*Sphacelotheca Cruenti* Kuhn Pot.). A powdery mildew (*Oidiopsis*) was found attacking the potato crop in Khed and Chakan. Other new diseases were caused by a species of *Synchytrium*, parasitic on betel vine, and a species of *Diplodia* attacking the camphor tree. Sugarcane in certain areas developed a suspicious mottling of the leaf but so far the early suspicions of mosaic disease have not been confirmed.

Bengal.—Ufra disease of paddy was not severe anywhere in Eastern Bengal during the year under review. Sugarcane suffered from "red rot" (*Colletotrichum falcatum* Went) at Charnagardi and demonstrations of sett selection were given. Experiments in spraying against die-back (*Vermicularia Capsici*) of chilli were carried out in Rajbari and liming the soil as a remedy against wither tip (*Colletotrichum gloeosporoides*) was attempted at Kalimpong.

United Provinces.—Some preliminary experiment on storage rot in potatoes were carried out and operations against red rot of sugarcane were instituted at Gorakhpur. Further work was impossible in the absence of equipment in the new mycological section.

Central Provinces.—Investigations on wilt disease in cotton were commenced and two strains of a *Fusarium* were isolated.

Indian Tea Association.—The research work was mostly confined to leaf diseases. Articles on Brown blight (*Glomerella cingulata* (Stonem) S. & V. S.) and Grey blight (*Pestalozzia Theae* (Sawada) have been published in the Quarterly Journals of the Department. An article on Copper blight (*Laestadia Camelliae*, Cke) has been prepared for publication.

Some experiments were made to determine the vitality of the conidiospores of *Glomerella cingulata* (Stonem) S. & V. S. and the pycnospores of *Laestadia Camelliae*, Cke. It was found that the pycnospores of *Laestadia Camelliae*, Cke in spite of their thick coat were only able to survive about a week when kept in the shade under the laboratory conditions of humidity and temperature. The conidiospores of *Glomerella cingulata* (Stonem) S. & V. S. only survived 1 day.

A species of *Colletotrichum* was isolated from the root of a dead tea bush.

A species of *Nectria*, found in some Cankerous tea stems, was investigated.

AGRICULTURAL BACTERIOLOGY

BY

J. H. WALTON, M.A., M.Sc.,

Officiating Imperial Agricultural Bacteriologist,

WORK AT PUSA.

Soil Biology.

Nitrogen.—Estimation of losses of nitrogen from cattle dung and urine stored under either ærobic or anærobic conditions show the necessity of anærobic storage for proper conservation of the nitrogen of the urine. Only fifteen per cent of the urine nitrogen was lost under anærobic conditions compared with eighty-five per cent under ærobic conditions.

Further experiments on the nitrification of mahua cake have been carried out. Composting the cake with rock phosphate and sulphur for four weeks has resulted in 25 per cent of the nitrogen of the cake becoming nitrifiable.

Indigo.

A simple colour test has been devised by Mr. W. A. Davis, the Indigo Research Chemist, by which the proper time of steeping the plant can be ascertained. An important factor in causing variations in the length of steeping required to give the best produce, quantity and quality both being considered, is the bacterial flora of the steeping water. Until Mr. Davis's test was employed, unsatisfactory results had been obtained with steeping water, inoculated with a pure bacterial culture that had worked well in the laboratory, both with and without sterilisation of the water before addition of the pure culture. When the steeping time was controlled by use of the test the first day's working gave produce of 78·5 per cent quality. The steeping water was first sterilised with E. C. the hypochlorite preparation made at Pusa and after 12 hours, inoculated with a culture isolated from water in Assam. Indigo of this high quality will prove of value for mixing with lower grades, for the manufacture of 20 per cent indigo paste for the far eastern market.

Detailed studies of the cultural characters and efficiency of indigo hydrolysing bacteria from various sources have been carried out in the laboratory.

Plant Diseases.

A bacterial rot of potatoes sent from Assam was investigated.

Work in the Provinces.

Biological studies of typical soils were carried on in the Central Provinces, Madras, and by the Indian Tea Association at Tocklai, Assam. In each of the soil types investigated at Tocklai, the soil optimum moisture for the best mechanical condition was the optimum for nitrate accumulation and carbon dioxide formation.

The decomposition of green manure plants at different stages of growth in the black cotton soil of the Central Provinces was investigated.

It was found that the earlier the stage of growth at which " sann " is used as a green manure, the more rapid are the processes of nitrification and the decomposition of carbonaceous substances. In the case of Dhaincha, there is no marked decrease in the rate of nitrification with the increasing age of the plant.

In the black cotton soil the stems of sann hemp did not retard the decomposition of the leaves, which is contrary to their effect in Pusa soil.

FORESTRY

Part I.—Silviculture

BY

S. H. HOWARD, B.A.,

Silviculturist.

The year under report is for nine months only owing to the recent change in the forest year which now coincides with the financial year. This report therefore can hardly be regarded as normal, especially as a large amount of work takes place between April and June none of which is included in this.

Perhaps one of the most important matters to comment on is that an efficient division of labour between the Local and Central Silviculturists is becoming more defined. It is beginning to be abundantly clear that the main division of labour will eventually be that Local Silviculturists will concern themselves more with experimental silviculture, pure and simple, while the Central Institute will control statistical work and be a general bureau of information. Bengal and Burma have, during the year, laid out the main lines of policy to be pursued in silvicultural research and it is hoped that other provinces will follow suit in the near future and appoint Local Silviculturists.

Statistical work.—A good many plots have been remeasured and a certain number of new plots have been laid out both by the Central Institute and by the Local Silviculturists. The new methods of calculation have now been finally adopted and a large portion of the former work has been converted to them. Data are as yet insufficient to publish proper yield tables but for certain species the time is rapidly approaching when approximate yield tables can be issued. When the policy of this work has been strictly laid down it should be possible to produce yield tables for several of the principal species and volume and form factor tables for others within the next five years provided staff is forthcoming. Owing to press difficulties the only statistical publication which has appeared is an article on Sal taper curves by E. A. Smythies and S. H. Howard in the Indian Forester but the following are in press :—

(1) Note on weights of seeds by S. H. Howard, B.A.

(2) Note on the rate of growth of Bengal Sal by S. H. Howard, B.A.

(3) A code for the collection and compilation of statistical data with Appendices by S. H. Howard, B.A.

(4) The Forest Pocket Book by the United Provinces Research Branch which contains various statistical data.

The Sal (Shorea robusta).—A good deal of experimental work was commenced in the United Provinces and in the Central Provinces on the natural reproduction of Sal, the cover being opened to various degrees and the ground cover being burnt or unburnt. Strip fellings, and ordinary clear fellings to let up established seedlings, both with and without burning of the slash, were tried by the United Provinces and Central Institute but there has been insufficient time at present to formulate definite opinions. An experiment in the Bengal taungya methods was projected in Dehra Dun but owing to no suitable arrangements having been made it had to be abandoned.

Various other minor experiments are in progress and the experiment on storing seed, commenced last year, gave promising results and will be repeated this year on a larger scale.

At present the problem of Sal regeneration is still unsolved in most districts.

Afforestation.—The experiments indicated for Zabarkhet in last year's report have as yet (March 31st, 1921) had no time to show any result except in the case of the Chir. Both in the ploughed lines and on the cleared ground this germinated well, has withstood the frost and looks promising. The afforestation area will be extended next year.

Many experiments have been made by the United Provinces in the Bhabar with various species. It has been conclusively shown that root and shoot cuttings of Sissoo (*Dalbergia Sissoo*) are a simple and effective method of afforestation even in lantana areas with no weedings if planted early and irrigated, but unfortunately irrigation is usually impracticable. It is hoped that the Zabarkhet method of winter planting with root and shoot cuttings will prove next year that the afforestation can be done in this way in grass areas with neither weeding nor irrigation.

Experiments with other species in the United Provinces have so far only shown again that weeding in the first rains is essential.

Work has been done by other provinces but up to date no conclusions have been reached.

Mr. Smythies brought out his Afforestation of the Jumna Ravines in Etawah (Indian Forest Record, Vol. VII, Part VIII). This is now being published in Urdu and Hindi. Mr. Benskin's book "Afforestation in the United Provinces" has been sent to Press.

Experimental Silviculture.—It is quite impossible to give any idea of the volume of work which has been done this year by the various provinces in a report of this length and reference is invited to Annual Report of Forest Research work in India. In most cases it is only the commencement of the work and no important results have as yet been obtained.

The camphor experiments have now yielded sufficient data and it is hoped to bring out a publication in the near future.

Mr. Champion's work on twisted fibre in Chir is being continued.

Two small interesting points reported from Behar and Orissa are worthy of notice., *viz.*, that Casuarina is highly susceptible to any maltreatment of the taproot and that teak seed burried in the soil, covered with alternate layers of straw and watered regularly for a fortnight produced much healthier and stronger seedlings than seed merely soaked for 48 hours prior to sowing.

Many other provinces furnished a mass of information too detailed to be reproduced here.

Development in Silvicultural Systems.—There is nothing special to report this year. Burma and Bengal continued to develop the taungya system of regeneration and extremely fine results are being obtained in both provinces. Up to date working plans are being rapidly compiled wherever staff and money is available. The improvement in the standard of working plans in the United Provinces since the creation of the Working Plans and Research Circle is most noticeable and Burma has now followed suit by creating a Working Plans Circle though there has as yet (March 31st, 1921) been insufficient time to see the good effects from this.

It can be confidently asserted however that other provinces must follow suit and create these special circles if their plans are to attain that standard which they should attain now-a-days.

Miscellaneous.—Though this report deals with only nine months it is surprising the amount of new work which has been done. There is no doubt that this is largely due to the appointment of Local Silviculturists and the standard of experimental work in those provinces where they exist is most noticeable. It is however becoming increasingly evident that the same high standard is not being attained in the statistical work. The compilation of statistical data is likely to become far more centralised in the near future.

FORESTRY

Part II.—Economic Forest Products

BY

R. S. PEARSON, C.I.E., I.F.S.,

Forest Economist.

Considerable progress in the preparations for the expansion of the Economic Branch was made during the year. The staff was strengthened by the arrival of specialists in Timber Testing and Seasoning, from Canada and America respectively, and Mr. Raitt, the officer-in-charge of all enquiries in connection with Paper Pulp, returned from deputation in England to take up his appointment as a whole-time officer at the Institute. A Wood Worker was also appointed and took up his duties. The timber testing machines and seasoning plant for which orders had been placed in America by the Forest Economist, in consultation with the officers concerned, arrived during the year and steps were taken immediately to erect most of the former in an existing workshop as a temporary measure pending their removal to the site on which the new workshops are shortly to be built. The erection of the seasoning kilns had to be postponed until the new site is ready owing to lack of space, but it is proposed to put up a temporary kiln in the Institute grounds for the purpose of giving demonstrations at the Forest Conference to be held in January 1922 and for seasoning the timber to be used in making furniture for the new Institute. A portion of the necessary wood working machinery was obtained in India and an experimental Rotary Veneer Cutting Machine and a Sawmill were purchased in America. All were received during the year. The up-to-date experimental paper and pulp plant, to arrange for which Mr. Raitt had been deputed to England in 1919-20, was manufactured during the year and despatched to India, and will be erected as soon as the new site is ready.

The staff has been chiefly engaged on organisation work in the respective sections, especially on designs and workshop lay-outs, and though this has taken up a very considerable portion of their time nevertheless new investigations have been started, especially in connection with timber testing, seasoning, paper pulp, minor forest products.

The Wood Technologist is due to arrive about January 1922 but the post of Wood Preservation Specialist, though sanctioned, has not been filled, as a suitable officer has not yet been found. A complete experimental antiseptic pressure plant was received from England which will be made use of when the buildings on the new site are ready.

Observation and encouragement of the Paper Pulp Industry in India and Burma.—The preliminary work to carry out new surveys of possible bamboo areas in Bihar and Orissa and Madras was undertaken and the Officer-in-charge also paid a visit to Burma in connection with grass pulp schemes. As soon as the machines are erected a complete series of tests on Savannah grasses will be carried out. A large number of enquiries on the question of utilising bamboo for paper pulp were dealt with by this section and advice on how to obtain technical training was frequently sought.

Antiseptic treatment of timber.—The experimental sleepers laid down from 7 to 10 years ago in open lines and treated by four different methods were inspected. Those laid in the line 10 years ago and treated by the Powellizing Process show that *Terminalia tomentosa* (Sain, Asna, Taukkhyan or Saj) are, with few exceptions, doing remarkably well. *Pinus longifolia* (Chir) and *Pinus excelsa* (Kail) are still doing well in dry localities, moderately so in damp and have all been rejected after from 9 to 10 years' service when placed in very damp localities. The two *Dipterocarps* (In and Kanyin) have lasted 10 years, the cause of rejection being deterioration under rail seat and around spike holes. Had both the *Pinus* and *Dipterocarps* been laid with bearing plates they would probably have lasted 2 or 3 years longer, bringing their life up to that of *Cedrus Deodara* (Deodar) or *Shorea robusta* (Sal) in similar localities. In the other experiments, treatment with Creosote and Earth Oil introduced in fairly large quantities has given better results than either treatment with a small quantity of high grade oil or treatment with Chloride of Zinc and Creosote. Several railways evinced increasing interest in these experiments and it is expected that a number of treating plants will be erected shortly. The results of the experiments are being prepared for the press.

Physical and Mechanical properties and seasoning powers of various timbers. (*i*) *Natural Seasoning.* The final inspection of the seasoning experiments in Bengal and the Central Provinces were carried out by the Officer-in-charge, Seasoning, and the results will be published in the near future.

(*ii*) *Artificial Seasoning.*—The apparatus for the four blower and three steam spray drying kilns is now coming to hand and it is hoped to erect the kilns next cold weather.

(*iii*) *Mechanical Properties of timber.*—The first tests being carried out on the new machines are on red and white wood of Spruce to determine its value for sleepers after impregnation. A complete project according to which tests on the more important Indian timbers will be undertaken is under preparation.

Finding of markets and new uses for timbers including the issue of bulletins.—A large number of enquiries from firms, both in India and abroad,

were replied to and bulletins on the following timbers were issued during the year :—

(1) *Dipterocarpus pilosus.*

(2) *Lagerstroemia Flos-Reginæ.*

Gums, Resins and Oleo-Resins.—The question of utilising the gum-oleo-resin of *Boswellia serrata* (Salai) was advanced a step further by the publication of Dr. Fowler's valuable note on the work he had carried out at the Indian Institute of Science, Bangalore. His process differs from that advocated by Mr. Puran Singh in that alcohol is not used as a solvent. The Gwalior State are about to erect a plant working by the solvent process, the results of which will be watched with great interest.

Rosha grass oil.—The steam distillation of Rosha grass oil is now carried on successfully as a commercial undertaking in the Central Provinces and the industry is likely to expand.

Tanstuffs.—The Officer-in-charge carried out a detailed investigation on tanstuffs in the Sunderbans, completing 80 analyses of various products in that locality, the results of which are given in his report entitled " Tanstuffs of the Sunderbans Forest Division " and published by the Department of Industries, Bengal. The Officer subsequently proceeded to North Burma and carried out analyses of Chestnut, Oak, *Dipterocarp* and other timbers, barks, fruits and leaves, the results of which indicate considerable possibilities of working them commercially.

Charcoal Briquettes.—Investigations have been continued in consultation with an American Briquetting firm to whom a consignment of 500 lbs. of charcoal and 100 lbs. of binding material has been sent for experiments. The main difficulty to be overcome is to devise a process of grinding the charcoal without undue danger of combustion taking place.

Woods suitable for :—(*i*) *Bobbins, Shuttles and Picking Sticks for Cotton and Jute Mills.*—Nearly 5,000 sample pieces of the following species :—

I. *Odina Wodier.*

II. *Albizzia procera.*

III. *Adina cordifolia.*

IV. *Wrightia tinctoria.*

V. *Holoptelea integrifolia.*

VI. *Stephegyne parvifolia.*

VII. *Michelia Champaca.*

VIII. *Stereospermum xylocarpum.*

IX. *Stereospermum chelonoides.*

X. *Anogeissus latifolia.*

XI. *Dyospyros macrophylla.*

XII. *Lagerstroemia tomentosa.*

XIII. *Dillenia pentagyne.*

XIV. *Polyantha ceracoides.*

XV. *Garcinia Morella.*

XVI. *Homalium tomentosum.*

were collected and sent to a leading firm in England for trial after they had been put through the seasoning kiln at Bareilly, which has kindly been placed at our disposal by the Conservator, Utilization Circle, until the kilns at Dehra Dun are ready.

(*ii*) *Ply woods.*—A visit was paid to the leading firms and it is satisfactory to note that the tendency to "cheesiness" in certain timbers referred to last year has been overcome and the prospects of the industry developing in India are bright.

ZOOLOGY

I.—GENERAL ZOOLOGY AND PHYSICAL ANTHROPOLOGY

BY

S. W. KEMP, D.Sc., F.A.S.B.,

Officiating Director, Zoological Survey of India.

Tours.—The following tours were undertaken by members of the department:—

	Days.
To Bombay from 7th April to 18th April 1920 by Major R. B. Seymour Sewell	12
„ Barkuda from 24th April to 1st May 1920 by Major R. B. Seymour Sewell	8
„ Simla from 14th May to 22nd May 1920 by Dr. N. Annandale	9
„ Barkuda from 17th June to 28th June 1920 by Dr. Baini Prashad	12
„ Barkuda from 13th August to 22nd August 1920 by Dr. N. Annandale	10
„ Naini Tal, Moradabad, Delhi from 31st July to 2nd September 1920 by Dr. Baini Prashad	34
„ Barkuda from 22nd September to 27th September 1920 by Dr. N. Annandale	6
„ Barkuda from 22nd September to 27th September 1920 by Dr. Baini Prashad	6
„ Delhi from 18th December to 25th December 1920 by Dr. S. W. Kemp	8
„ Waltair from 19th January to 29th January 1921 by Dr. S. W. Kemp	11
„ Port Blair from 12th February to 20th March 1921 by Dr. S. W. Kemp	37
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Dr. Baini Prashad's tour to Naini Tal and Moradabad was undertaken in continuation of the survey of the freshwater molluscs which is being made at the request of the medical authorities. Barkuda island was visited on a number of occasions in order to carry out experiments in the intensive study of the fauna of a small localised area.

Dr. Kemp's visit to Port Blair was undertaken in order to discuss the establishment of the proposed Marine Biological Station with the Chief Commissioner of the Andaman and Nicobar Islands and to select a site.

Publications.—The following publications have been issued during the year :—

"Records of the Indian Museum," Vol. XVII.

"Records of the Indian Museum," Vol. XVIII, parts III—V.

"Records of the Indian Museum," Vol. XIX, parts II—V.

"Records of the Indian Museum," Vol. XX.

"Memoirs of the Indian Museum," Vol. V, Nos. 7 & 8.

Library.—The total additions to the library number 1538. Of this number 826 books and parts of periodicals were received in exchange, 583 were purchased and the remainder presented.

Collections.—The collections have remained in good condition and numerous additions have been made to them apart from those obtained by the officers of the Survey themselves.

Valuable collections of Crustacea have been obtained by exchange from the British Museum and from the museums at Paris, Cambridge and Milan. Professor Max Weber has sent us a duplicate set of the Molluscs which he obtained in his Expedition to the Dutch East Indies and a valuable collection of shells has also been obtained by purchase from Lieutenant-Colonel H. H. Godwin Austen, F.R.S.

Additions to the insect section include a number of valuable specimens presented by Major F. B. Scott, Mr. C. J. Drake and Major F. de Mello.

Our collection of hill-stream fishes belonging to the genus *Discognathus*, which had been lying with Dr. Pitschmann in Vienna since before the beginning of the war, has now been returned. A collection of flies belonging to the family Dolichopodidae which had been in Germany throughout the period of the war has also been received back.

Galleries.—The Invertebrate Gallery still remains closed but it is hoped that half of it will be refitted and opened to the public during the course of the next financial year. Owing to the present high price of plate glass it has been difficult to complete the alterations in this gallery expeditiously.

To the Ethnological Gallery a number of specimens from Manipur and Baroda States have been added. A special collection from the Nicobar Islands was made and presented by Mr. H. Hart making the exhibit of the ethnology of these Islands almost complete.

ZOOLOGY

II.—ECONOMIC ZOOLOGY

Part I.—Agricultural Entomology

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,

Imperial Entomologist.

It should be noted that, in compliance with orders of Government that the Report on Agricultural Entomology in India during the year ended 30th June 1921, should not exceed four pages, exclusive of bibliography, only a very brief summary of the work done at Pusa and in the Provinces can be given here.

I.—Work at Pusa.

Numerous observations on Insect Pests were made and a fuller account of these will be found in the Scientific Report of the Pusa Research Institute for this year. Investigations were continued on pests of cotton, rice, sugar-cane and other gramineous crops, fruit and stored grain. Life histories of numerous insects have been worked out and illustrations prepared. Work on Bees, Lac and Silk was continued on previous lines. Steady progress was made in the additions to and arrangement and identification of the collection. The scheme for the preparation and publication of a catalogue of Indian insects has been approved and is being pressed on. The Fourth Entomological Meeting, held at Pusa from 7th to 12th February 1921, was attended by over forty members who contributed fifty papers which are being issued in the Report of the Meeting.

II.—Work in the Provinces.

Madras.—Attention was mainly devoted to the study of *Platyedra gossypiella*, *Pempheres affinis* and *Schœnobius bipunctifer*. The rate of increase of *P. gossypiella* in green cotton bolls and the comparison of the percentage of attack of areas under the Pest Act as compared with those outside its jurisdiction were studied, with the result that a notable decrease was found in the Pest Act area. The study of *P. affinis* was continued in connection with the intensity of attack in different strains of Cambodia cotton ; the natural enemies were found to include a Braconid parasite and a fungus. Experiments with the control of *S. bipunctifer* in the Kistna district were continued and gave

satisfactory results. The study of *Yerra tegelu*, a mysterious disease of paddy in the Godavari delta, was taken up. Other pests dealt with included *Spodoptera mauritia* on paddy in Malabar and Capsid bugs attacking cotton.

Bombay.—Demonstrations and lectures on control of pests were given in Gujarat. Investigations of granary pests and of their parasites were made. Experimental work was also done on control of Hairy Caterpillars, *Juar* stem-borers (*Chilo simplex* and *Sesamia inferens*), cotton-pests, surface grass-hoppers (*Chrotogonus* spp.), *Urentius echinus* on brinjal, pests of *tarwad* [apparently *Sesbania* sp.] and cattle ticks.

Central Provinces.—Rearing of wood-borers in mango, *Lagerstrœmia indica*, *Zizyphus jujuba*, *Ficus religiosa* and *Phyllanthus emblica* showed that both "*Arbela*" *tetraonis* and *A. quadrinotata* were present. Observations of the occurrence of *Carpomyia vesuviana* and *Meridarchis scyrodes* in *ber* fruits showed that the pupal stages of both these insects may be prolonged for several months in the hot weather. Obervations were made on the parasitization of *Sphenoptera gossypii* by *Xanthopimpla punctata*. Study of the insect fauna of weeds was continued. A small undetermined weevil was reared from flowers of *Zizyphus jujuba*.

United Provinces.—The main work has been the investigation of cotton pests and has been preliminary to a study of *Platyedra gossypiella* and other pests of cotton. Some attention has also been paid to pests of sugarcane and mango.

Punjab.—The percentage of bollworm attack on cotton was not very high this year and in most places was below normal. The life history of *Microbracon* sp., parasitic on *Earias*, was studied and it was found that a single female may lay over 200 eggs, the life-cycle being completed in about ten days in summer, lengthened to 30 days in winter. The life history and control of mango-hoppers (*Idiocerus atkinsoni* and *I. clypealis*) were studied and winter spraying with a strong contact poison was found effective. Spraying operations with tobacco decoction or crude oil emulsion were found effective against *Euphalerus citri*, on Citrus trees, and are becoming very popular. Some work has also been done on control of rats, mainly by the use of strychnine. Experiments were carried out to test the efficacy of the use of heat for the control of granary pests. Sericultural work has been continued and 1750 ounces of eggs were under rearing in 1921, as compared with 600 ounces in 1920; unfortunately, the unusually hot season killed off most of the worms at the time of spinning their cocoons.

Bihar and Orissa.—Work on the Braconid parasite of *Agrotis ypsilon* was continued on the lines of (1) breeding the parasite through the hot weather and Rains, and (2) ascertaining the factors which may be utilized in inducing dormancy in freshly-formed cocoons. As a result it has been found impossible to carry this parasite on in an active condition in the Plains in the absence of a cool room, and that freshly-formed pupæ, when exposed to a constant humidity of 5°, at once become dormant and remain healthy until revived by

exposure to favourable conditions of temparature and moisture. A large number of pupæ is being kept this summer for experiment and use at the beginning of the cold weather.

Bengal.—The use of cloth bags, to protect young mango fruits before egg-laying of the weevil, was found successful against *Cryptorrhynchus gravis* in the case of small trees of valuable fruits, which are worth the cost and trouble. Control work was done against *Arbela tertaonis*, Litchi Mite, and *Brachytrypes portentosus*.

Assam.—Work was done on the control of rice pests (*Hispa armigera*, *Leptocorisa varicornis* and *Schœnobius bipunctifer*). Serious damage by *Hispa* occurred in an extensive area near Srimangal, whilst there was an unusually severe attack of Rice Grasshopper in the neighbourhood of Hajo. *Diacrisia obliqua* attacked pulse, crops and jute.

Burma.—Investigation of *gwabo*, a disease causing yellowness in growing paddy and empty grains in a part or whole of the ear, was commenced, but only about 5 to 8 infestation by borers was found. The borers found in rice prove to be *Schœnobius bipunctifer*, *Sesmia inferens* and *Diatræa* sp. (Pusa, C. S. 1674), of which the first-named is the most important. At Hmawbi where paddy selection work is being carried on, some varieties showed markedly greater infestation than others, thus indicating that some varieties are more resistant to insect attack. *Hispa armigera* occurred in Kyaukse district in June and was found only on Ngasein paddy. The main damage to sugar-cane in Upper Burma appears due to Termites. *Andropogon sorghum* is quite free from borers at Mandalay, apparently due to the absence of *Chilo simplex* in Burma. The main pest of cotton is *Platyedra gossypiella*. *Oryctes rhinoceros* was under investigation, the grubs breeding chiefly in the village manure heaps. Fruit-flies in peaches and pears at Maymyo do serious damage, apparently due to a complete absence of parasites.

III.—Native States.

Travancore.—*Nephantis serinopa* on coconut was the most important pest of the year and was dealt with by cutting and burning the affected leaves, the Pest Act being enforced and more than 35,000 trees treated. The method of control of *Leptocorisa varicornis* on rice, by bagging the bugs, was demonstrated with success. Pests of ginger were also under observation and a species of *Calobata*, boring in the rhizome is stated to be very destructive.

Mysore.—Field-work against *Amsacta albistriga* and *Discrisia obliqua* has been continued; against the former the Pest Act has been continued to be enforced over a considerable area with satisfactory results. Field-work on the control of *Xylotrechus quadripes*, on coffee, by painting the stems with Brunolineum just after oviposition, has yielded successful results. Control of *Oryctes rhinoceros* has been carried out on an extensive scale in a Government Date Reserve, by destruction of rotting stumps and of the larvæ found in manure pits. Parasites of mangoleaf-hoppers have been under investi-

gation and their life histories worked out. Work has also been done on cane borers, *Juar* Cecidomyiad, *Spodoptera mauritia* and *Chloridolum alcmene*.

Hyderabad.—
Kashmir.—
Baroda.— } No scientific work is reported.

IV.—Other Entomological Work.

Indian Tea Association.—The attention of the entomological branch was devoted to further investigations into the control of "mosquito blight" (*Helopeltis theivora*, Waterh.). Experiments on the inoculation of bushes were carried out on an extensive scale in all districts and have confirmed the result, previously obtained, that inoculation of the bush with salts of potash gives a decided increase to the resisting power of the bush to attack. The manuring experiments have also shown that the degree of resistance to attack can be altered by manuring, but that whereas bushes on different types of soil respond similarly to direct inoculation with potash, the results obtained from manurial applications differ with the type of soil.

Observation of cases where the intensity of attack differs greatly on areas on the same soil, but under different management have afforded evidence that bushes on the same soil will differ in liability to attack when the soil is treated differently, this difference in degree of liability to attack being correlated with an increased proportion of potash in the growing leaf, and examination of bushes throwing off attack has shown that this increasing resistance is accompained by a distinct increase in the proportion of potash present in the growing leaf.

Breeding records have been kept throughout the year in connection with the green fly pest of tea (*Empoasca flavescens*, Dist.).

South Indian Planting Districts.—No work on Entomology was carried out.

ZOOLOGY

II.—ECONOMIC ZOOLOGY

Part II.—Forest Entomology

BY

C. F. C. BEESON, M.A., I.F.S., F.E.S.,
Forest Zoologist.

Insects of Sal.—Borers (*a*) *Field work.*—In the area of the epidemic occurrence of *Hoplocerambyx spinicornis* in Thano Forests, Dehra Dun, observations were continued on the plan of previous years involving enumerations and plane-table surveys. Particular attention was paid both in the insectary and field to the effects of edaphic and climatic conditions on the incidence of the borer, which is now correlated with rainfall. The recognition of a connection between the periodic abundance of the borer, the resistance of the host tree to attack and rainfall during the flight period of the beetles, has materially altered existing conceptions of the economic status of the pest. It is now apparent that in a series of years of high rainfall, the increase of the borer is favoured and the resistance of the host tree is lowered; in years of low rainfall the reverse effect occurs. If the monsoon fails during the course of a borer epidemic the proportion of trees fatally attacked is reduced (in spite of the relatively increased incidence of the borer) to such an extent that the pest receives a marked check. Control measures based on above results have been formulated and put into practice during the 1920-21 season. It is anticipated that given a valuation of the growing stock and its increment, a safety limit expressed in deaths per acre and a safety period for control operations can be determined. A note on the connection of *Hoplocerambyx* with the dying off of sal has been published in the Indian Forester for February 1921.

In tours made in Singhbhum and Porahat Divisions, Bihar and Orissa, it was determined that *Hoplocerambyx* is rare or absent in dry and hill type sal forests, and that it is usually a secondary effect of *Polyporus shoreæ* in the moist and valley type sal; a condition suspected some years before in the Bengal Duars forests. The frequent mortality of sal without the assistance of borer attack leads one to consider that borers of the type of *Hoplocerambyx* are essentially secondary factors, which however under epidemic conditions may determine the death or survival of a weakened tree.

(*b*) *Insectary work.*—Further insectary records of the development of *Aeolesthes holosericea*; *Xylotrechus smei*; *Platypus* spp; *Diapus* spp. and *Xyleborus* spp. have contributed to the establishment of the economic status of these species and revealed the extent to which their prevalence is affected by climber-cuttings and girdling or felling without removal of inferior species.

Other pests.—The seed weevil, *Calandra shoreæ*, has been found to have a wide distribution and a variety of dipterocarp host-plants.

Insects of the teak.—Work on the collection of further statistical data on the beehole borer, *Duomitus ceramicus*, has been in abeyance. Further records of the minor sap-wood borers and shot-hole beetles have been obtained in the insectary.

Miscellaneous pests.—During the year under report 125 consignments of specimens (including 903 insects) were received for investigation. The determination of the borer fauna of timbers seasoned by various natural processes received attention. A total of 910 pieces of timbers has been received from divisions and some 8,500 insect specimens have been bred out, adding considerably to our information on the food trees and distribution of timber pests.

A short survey was made in the Sunderbans, Bengal, of the borer fauna of swamp, slump and cyclone-killed trees and drift timber to obtain evidence on the survival or destruction of boring insects by immersion in brackish and salt water.

The compilation of the food-plants of forest insects has been continued with the issue of the families *Platypodidæ* and *Scarabæidæ*.

Insect collections.—Small batches of forest insects have been identified and returned by the following specialists: *Endomychidæ*, *Erotylidæ* and *Lamellicornia* by Dr. G. Arrow; *Adephaga* and *Carabidæ* by Mr. H. E. Andrews; *Tenebrionidæ* by Mr. K. G. Blair; *Diptera* by Mr. E. Brunetti; *Cleridæ* by Mr. J. Corporaal; *Formicidæ* by Mr. St. J. Donisthrope; *Odonata* and *Pyralidæ* by Mr. T. B. Fletcher; *Odonata* by Major Fraser; *Bostrychidæ* by Mons. P. Lesne; *Curculionidæ* by Dr. G. A. K. Marshall; *Micro-lepidoptera* by Dr. E. Meyrick; *Asilidæ* by Miss G. Ricardo; *Termitophila* by Mr. Wasman; *Apidæ* by the Government Entomologist, Madras.

Some 350 species new to the Research Institute collection have been added during the period under review.

Staff.—Messrs. D. Atkinson and J. C. M. Gardner who have been selected for appointment to two of the posts of Divisional Forest Entomologist complete their training in forestry and entomology at the close of 1921. Mr. J. M. D. Mackenzie, I.F.S., will be appointed as Divisional Forest Entomologist to investigate the beehole borer in Burma.

VETERINARY SCIENCE

BY

W. A. POOL, M.R.C.V.S.,

Officiating Director and First Bacteriologist, Muktesar.

Rinderpest.—The following experimental work was taken in hand :—

(1) The preparation of anti-rinderpest serum using animals of moderate susceptibility as virus producers.

(2) A further investigation into the duration of the immunity conferred by serum alone.

(3) An investigation into the nature of the immunity conferred by very large doses of serum when given simultaneously with a dose of virulent blood.

(4) The elaboration of a special apparatus for bleeding the virus producers and injecting the serum producers for use in large scale rinderpest serum production. Bulletins on these subjects are in course of preparation and will shortly be sent for publication.

Equine Contagious Abortion.—Experiments were carried out with a bacillus obtained from aborted fœtuses at the Government Cattle Farm, Hissar, which proved to be the *B. abortivo equinus*.

An account of these experiments will be published shortly.

Reports from Veterinary Colleges and Provincial Laboratories.—With the exception of those detailed below no scientific work of any particular interest was carried out by the Veterinary Colleges and the Provincial Superintendents of the Civil Veterinary Department except that the Superintendent, Civil Veterinary Department, Madras, states that " a special work is being conducted on the causation of lymphangitis in cattle as occurring in Madras at the Madras Veterinary College, but is not yet completed."

The Director of Agriculture, Punjab, gives the following short summary of the Scientific Work carried out by the local Veterinary Officers in the Punjab during the year 1920-21 :—

I. *Camel Specialist, Sohawa.*

" The treatment of surra in camels by intravenous injections of Tartar Emetic. As the result of these experiments Tartar-Emetic gives promise of being efficacious in the treatment of this disease. Several months after

these camels had been returned to duty Sir John Moore informed me he had inspected them and found them in excellent condition. These camels are now working in Waziristan.

2. Experiments in connection with camel mange and its treatment. Of different dressings tried, the best results have been obtained by Taramira oil.

3. Surra Transmission Experiments.

4. Experiments were carried out in connection with spirochætosis of fowls, from which it was shown that 95 per cent. of infected fowls can be cured by intravenous injections of Soamin.

5. Observations were made with reference to Hypoderma larvæ of goats and the best means to be adopted to reduce the loss caused by these larvæ were studied, the life history of the fly was also studied.

II. *Principal, Veterinary College, Lahore.*

1. Work at Antirabic inoculation in dogs by Mr. W. Taylor.

2. Investigations in a curious Poultry disease by Messrs. Taylor and Sewell.

III. *Government Cattle Farm, Hissar.*

Feeding experiments on cattle with cake and leaves of certain trees."

MEDICAL RESEARCH

BY

The HON'BLE MAJOR-GENERAL SIR WILLIAM RICE EDWARDS, K.C.I.E., C.B., C.M.G., M.D., F.R.C.S.E., K.H.P., I.M.S.,

Director-General, Indian Medical Service.

The following is an extract from the Annual Report of the Scientific Advisory Board of the Indian Research Fund Association for 1920-21 :—

Relapsing fever.—An enquiry into relapsing fever with particular reference to the mode of transmission in India was sanctioned in November 1920 but started in February 1921. It is being carried out by Major F. W. Cragg, I.M.S., of the Central Research Institute in the United Provinces, Central Provinces and Punjab.

Plague and Rat-fleas.—The Governing Body of the Indian Research Fund Association have sanctioned an investigation on rat-fleas in India by Major Cragg.

Leprosy.—1. *Dr. E. Muir* is engaged at the Calcutta School of Tropical Medicine in carrying out an inquiry into leprosy with an allotment of Rs. 20,000 a year of which Rs. 10,000 will be donated by the Calcutta School of Tropical Medicine. The inquiry commenced on the 1st November 1920.

2. *Dr. Sudhamoy Ghosh* continued his researches under the supervision of Lieut.-Colonel J. W. D. Megaw, I.M.S., on special duty, at the School of Tropical Medicine and Hygiene. He is especially studying the chemistry of chaulmoogra oil with a view to obtaining substances of therapeutic value in the treatment of leprosy.

Grant to Rev. Dr. Frank Oldrieve for—

(1) Training of medical subordinates in modern methods of leprosy treatment, and

(2) Trial of the latest treatments of leprosy.

A grant of Rs. 21,650 was made to the Mission for Lepers in India in 1918 in connection with the experiments relating to the medical treatment of leprosy.

Inquiry on neem or margosa oil and its derivatives.—This inquiry has been extended for one year from 1st March 1921 and Dr. Chatterjee is concentrating his attention on the treatment of malignant growths with neem or margosa oil and its derivatives.

Influenza.—1. *Epidemiological inquiry.* This inquiry was under Major H. H. King, I.M.S., and terminated on the 7th April 1921 on his departure on leave. He has drawn up an important report for All-India dealing with the questionnaire regarding the epidemiology, etc., of influenza issued by the

office d'Hygiene International, Paris. This has been received and sent to Paris. (Since published in the Bulletin de L'office D'Hygiene Institute, August 1921.)

2. *Bacteriological inquiry.* Captain R. H. Malone, I.M.S., concluded his influenza bacteriological inquiry on the 4th December 1920.

Pneumonia.—On the conclusion of the influenza bacteriological inquiry Captain Malone was employed on the Pneumonia inquiry. This inquiry was sanctioned for one year in the first instance with effect from 5th December 1920.

Deficiency Diseases.—Colonel McCarrison started this research on the 29th January 1921 in England. This investigation is being carried out at Oxford in the Laboratory of Professor Sherrington, P. R. S.

Indian Mosquitoes.—The Indian Research Fund Association have provided funds for this inquiry to be continued for three years by Capt. P. J. Barraud. It commenced on the 26th February 1921.

This inquiry is on the culicidæ of India and has a direct and important bearing on the problem of prevention of yellow fever.

Kala-azar.—1. *Mrs. H. A. Adie* concluded this inquiry on the 25th January 1921. She published* a paper on "Developmental forms succeeding the multiplicative stage in *C. lectularius* fed on Kala-azar spleen uice". The Indian Research Fund Association has sanctioned the further continuance of the inquiry under her at Shillong for one year and she commenced fresh researches on possible insect vectors of this disease from 26th April 1921. She will work at the Pasteur Institute, Shillong, under the direction of Major F. P. Mackie, I.M.S.. She has already obtained some very suggestive and interesting results.

2. The Governing Body have sanctioned a further extension of Dr. U. N. Brahmachari's enquiry for one year. He has been provided with a chemical and physiological assistant and he will continue his researches on the organic preparations of antimony.

3. *Mr. P. R. Awati,* Medical Entomologist, commenced his insect survey in connection with Kala-azar in Assam in May 1920. He continued his work during the year. He is one of the team of workers engaged in Assam in the research on the etiology of Kala-azar.

Hookworm disease.—The inquiry into this disease was continued by Dr. K. S. Mhaskar during the year. In conjunction with Father Caius he published six more papers on the chemical composition of various drugs used in the treatment of the disease. Under instructions from the Working Committee in Madras, formed at the end of the year under review, he has been directed to proceed with new lines of research.

Ground nuts and sterilisation of water supplied by chlorogens.—Dr. Mackenzie Wallis is continuing his research in England. A report of his investigation has been called for.

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* Indian Journal of Medical Research, Vol. 8, No. 7, October 1921.

Schistosomiasis cercariae of Egypt.—Major Sewell has written a very important monograph entitled *Cercariae Indicae* being the result of his investigations on this subject in India. This paper is being published by the Indian Research Fund Association as a Monograph in a special number of their Journal.

Entomology and Protozoology.—In the month of January 1921, Major W. S. Patton, I.M.S., conducted his inquiries on entomology and protozoology for which a grant of Rs. 5,000 was sanctioned by the Governing Body of the Indian Research Fund Association.

Immunity with special reference to antivenin.—The Governing Body of the Indian Research Fund Association have sanctioned for a period of one year a research on immunology with special reference to antivenin by the Rev. Father J. F. Caius of Trichinopoly. One of the main objects of this inquiry will be the concentration of the antivenin serum now prepared at Kasauli.

Malaria and its treatment by Cinchona derivatives.—This inquiry will be carried out by Major J. A. Sinton, V.C., I.M.S., under the direction of the officer in charge of the Malarial Bureau of the Central Research Institute *of Kasauli. The inquiry* will be carried on over a period of five years.

Grants to the schools of Tropical medicine and Hygiene at Bombay and Calcutta.—The Indian Research Fund Association have sanctioned :—

(*a*) The sum of Rupees one lakh towards the extension of the buildings of the Calcutta School of Tropical Medicine to provide for teaching and research in hygiene and (*b*) a non-recurring grant of 1½ lakhs towards the establishment of the School of Tropical Medicine at Bombay.

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Departmental Publications

I.—Meteorological Department—

Government of India Office.

(1) The Indian Daily Weather Report and Chart.

(2) The Weekly Rainfall Summary.

(3) The Monthly Weather Review.

(4) The Annual Summary.

(5) The Rainfall of India.

(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.

(2) Monthly Rainfall Tables and Summaries of the chief feature of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.

(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.

(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).

(2) Annual Summary.

(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(1) Monthly Summary } of Punjab weather.
(2) Annual Summary }

II.—Geological Survey.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I.—XLV, including the larger papers on geological subjects.

Records, Vols. I—L, including the shorter papers and Annual Reports from 1868 to 1915 sold in parts, priced one rupee each.

Manual, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

III.—Survey of India.

(1) Annual General Report.

(2) Professional Papers.

IV.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.

(2) Records of the Botanical Survey, Vols. I—IX

(3) Annual Report of the Industrial Section, Indian Museum.

(4) Annual Report of the Royal Botanic Garden, Calcutta.

(5) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII, Part II.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with Entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British *India by the Inspector-General of* Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(5) The Indian Forester.—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal, published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) Records of the Indian Museum, 8vo. Containing short papers on Indian Zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalouge of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

CALCUTTA : PRINTED BY SUPDT. GOVT. PRINTING, INDIA, 8, HASTINGS STREET.